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Report of the Secretary of Labor's Advisory Committee on the Elimination of Pneumoconiosis Among Coal Mine Workers

Submitted by the Committee to:

U.S. Department of Labor
Robert B. Reich, Secretary

Mine Safety and Health Administration
J. Davitt McAteer, Assistant Secretary

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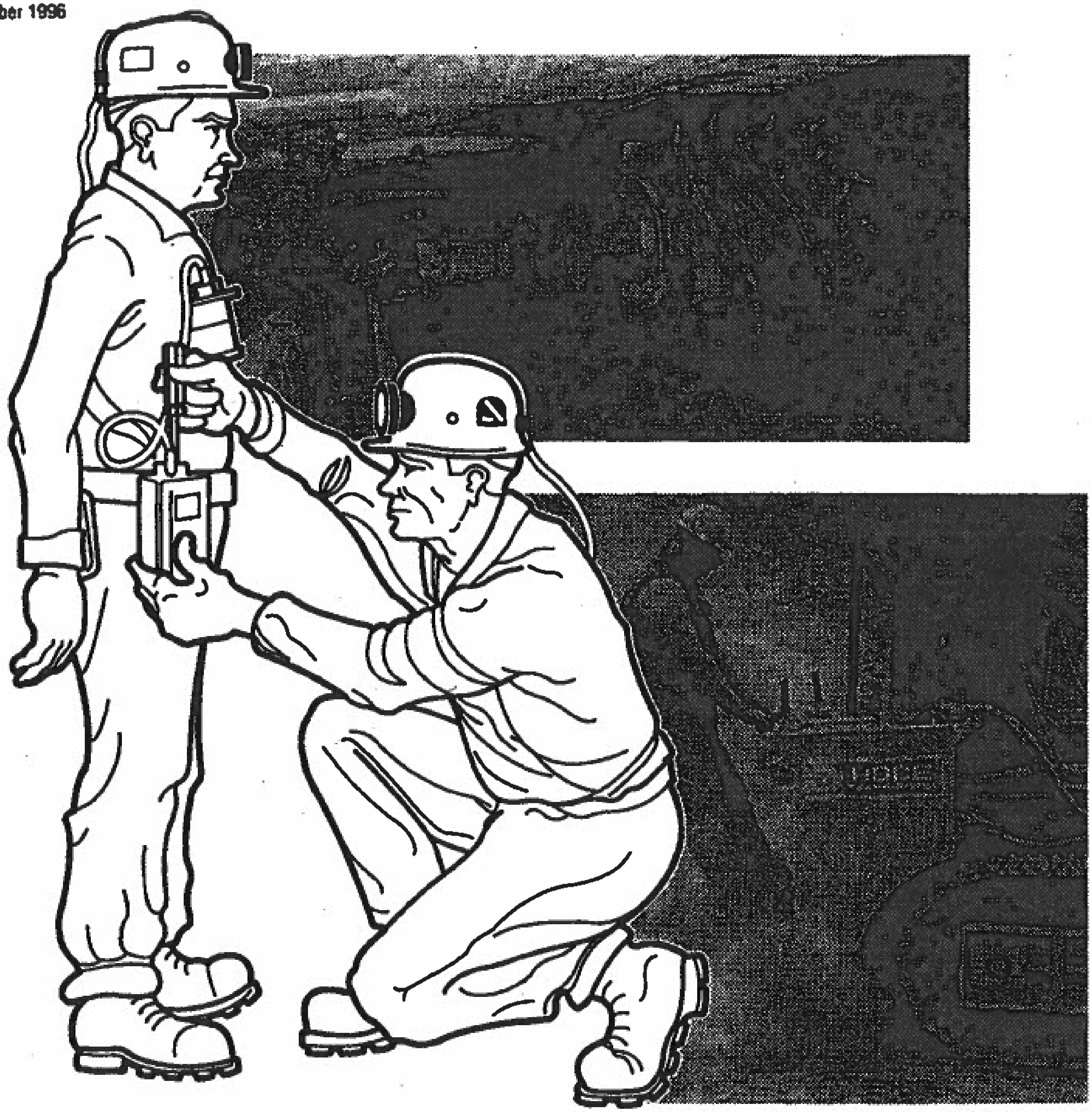

Excerpts from:

Report of the Secretary of Labor's Advisory Committee on the Elimination of Pneumoconiosis Among Coal Mine Workers

United Mine Workers of America
June 20, 2019

The following is a list of the Committee members.

Neutrals

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Joseph Lamonica, Vice President for Health, Safety, and Training Bituminous Coal Operators' Association Washington, D.C.

IV. STATEMENT OF COMMITIEE RECOMMENDATIONS

The Committee was charged with providing recommendations of ways to improve the program to control respirable coal mine dust and silica dust in underground and surface coal mines in the United States. Specifically, the charge of the Committee was to make recommendations to the Secretary for improved standards or other appropriate actions on permissible exposure limits to eliminate black lung disease and silicosis; the means to control respirable coal mine dust levels; improved monitoring of respirable coal mine dust levels and the role of the miner in that monitoring; and the adequacy of the operator's current sampling program to determine the actual levels of dust concentrations to which miners are exposed. The following is a statement of the Committee recommendations.

RECOMMENDATION NO. I

MSHA should consider lowering the level of allowable exposure to coal mine dust. Any reduction in the level should include a phase-in period to allow allocation of sufficient resources to the compliance effort.

In the interim, the operators, MSHA and miners should develop a comprehensive program to assure compliance with the current permissible exposure level. This effort should include at least targeted compliance efforts, sharing of documented exposure reduction approaches (e.g., increased water sprays, scrubbers on continuous miners, dust control plan parameters), and increased "good faith effort" consideration in enforcement actions.

RECOMMENDATION NO. 2

MSHA should develop and enforce separate PELs for exposure to silica and coal mine dust.

MSHA should explore appropriate methods for determining compliance with exposure limits for mixtures of silica and coal mine dust.

RECOMMENDATION NO. 3

The Committee suggests that MSHA cause the lowering of the silica exposure of miners. In this effort, MSHA should seek input from NIOSH and collaborate with OSHA. However, the *Committee* recommends that MSHA move forward with these efforts and not await possible action by OSHA. MSHA efforts to lower silica exposures below the current PEL might include rulemaking, targeted compliance efforts, encouragement of operator efforts to lower silica exposures below the current PEL, and more extensive siliG hazard surveillance. Additionally, MSHA must confirm the accuracy of its analytical procedures to assure that actual exposures are recognized and documented.

RECOMMENDATION NO. 4

Environmental control measures should continue to be the primary means of maintaining respirable dust levels in the mine atmosphere in the active workings in compliance. Respiratory protective equipment should not replace these control measures but should continue to be provided to miners until environmental controls are implemented that are capable of maintaining the respirable dust level in compliance. Administrative controls should only be utilized in situations similar to respiratory controls--as interim control measures while environmental controls are being installed.

RECOMMENDATION NO. 5

Administrative

MSHA should develop an administrative review process for timely approval of new or revised plans to permit testing of the adequacy of the plan. The process should consider the proposed changes in plan parameters and their potential effectiveness based on available performance data, current or projected operational parameters and production levels, the mine operator's previous history of ability to maintain compliance with the dust standard and plan parameters, and the proposed test schedule to assess the effectiveness of the new or revised plan parameters.

MSHA should define the range of production levels which must be maintained during sampling to verify the plan. This value should be sufficiently close to m um anticipated production to reasonably assure the operator and the miner that the plan will be effective under typical operations. MSHA should review compliance and production records to determine when there is need for plan modification and verification.

MSHA should develop criteria detailing when plan modification is required. These criteria should include changes in mining conditions, including production.

Operator Verification

MSHA should require operators to collect respirable dust samples to evaluate the adequacy of a new or revised plan under typical mining conditions within 30 days of granting provisional approval of the new or revised plan parameters. If found to be effective, MSHA should extend the provisional approval until MSHA can undertake independent verification of the revised plan.

If not found to be effective, a modified plan should be submitted to MSHA, including documentation of interim methods to control personnel exposure, in order to establish minimum critical control parameters reasonably anticipated to be adequate for dust control under typical mining conditions. Results of operator samples and analyses of these data, along with information on actual production levels and dust control parameters in use during operator monitoring, should be submitted with the modified dust control plan. MSHA should not issue citations for violation of the applicable dust standard based on this operator verification sampling. Operator inaction to protect miners where dust values are in excess of the PEL should be citable by M S H A .

MSHA Verification

Within 30 days of receipt of operator verification data documenting that the plan is effective, MSHA should, in consultation with the operator, perform scheduled independent dust monitoring to verify the operator's plan.

Final, minimum operating dust control parameters of the dust control plan should incorporate values measured by MSHA during sampling and, if needed, appropriate data from operator sampling.

If the production level at the time of the verification inspection is sufficiently close to the maximum anticipated production in the proposed plan, the production level in the proposed plan should be the approved maximum production level so long as the respirable dust level is at or below the permissible exposure limit. Otherwise, the production at the time of the verification shall be the basis of the approved production level.

Continued Monitoring

MSHA should develop specific performance requirements for operator sampling relative to documentation of continued adequacy of the plan parameters. MSHA should require that the results and monitoring of dust control parameters and production be recorded in order that correlation of dust control parameters with dust measurements is facilitated.

Operator Responsibility

Operator monitoring for compliance with the dust control measures established in the mine ventilation plan should be consistent with the new on-shift examination requirement of § 75.362(a)(2). Although no recordkeeping is required as part of this examination, the Committee believes that results of such examinations are informative and, therefore, should be recorded and shared with workers who have been properly trained concerning their interpretation and importance. MSHA should further explore the level of detail needed for recorded data.

Whenever on-shift examinations indicate that the plan's minimum requirements are not being complied with, operators should be required to take appropriate corrective action as specified in 30 CFR § 75.362(a)(2). Operators should conduct periodic reviews of the adequacy of the dust control parameters stipulated in the mine ventilation plan and make modifications necessary to achieve and maintain compliance with the applicable dust standard.

MSHA Responsibility

MSHA inspections should include a review of recorded parameter data, dust control measures observed in operation and input from miners regarding whether controls and production are representative of usual operations.

MSHA should examine all recorded operational data and information on miner exposure and dust control measures in place as part of the on-going and six-month reviews of the ventilation plan. These reviews should be designed to evaluate the continued effectiveness of the plan.

RECOMMENDATION NO. 6

During this verification visit, miners and their representatives should have the same paid I03(f) walkaround rights as they do under MSHA inspections.

RECOMMENDATION NO. 7

MSHA should specify the circumstances in which dust control plans are needed for surface mines, surface facilities, and surface areas of underground coal mines. MSHA should develop the relevant parameters for surface dust control plans and a process for plan verification.

Dust surveillance should be conducted at surface facilities and each surface area of an underground coal mine by examining locations where dust generation and miners' exposure occurs. When operations/activities not previously covered by a plan as specified in (I) above are found to have exposures at or above *Yi* the PEL, those operations/activities must be covered by a plan.

The parameters of the approved dust control plan should be verified as part of the operators' daily inspection requirements of 30 CFR 77.1713.

RECOMMENDATION NO. 8

MSHA should complete research (in consultation with other agencies such as NIOSH) to study the relation between indices collected from continuous monitors and the traditional methods of assessing exposure to respirable dust when these different methods are applied to the function of hazard surveillance as well as when developing other potential uses of continuous monitoring data (for example, compliance activity).

Once the technology for continuous dust monitors has been verified, these monitors should _be broadly applied in conjunction with other sampling methods for surveillance and determmatlon of dust control at all: MMUs and other locations at high risk of elevated dust exposures.

Once verified as reliable as in (I) above, MSHA should use continuous monitor data for assessing operator compliance efforts in controlling miner exposures, and should consider use of continuous monitor data directly in compliance.

MSHA should take whatever action possible to expedite the development and field testing of a continuous personal monitor to serve a variety of purposes, among them identifying sources and levels of exposure to respirable dust and, as appropriate, for compliance.

RECOMMENDATION NO. 9

In addition to the chest radiographs at the time of employment and then at the specified intervals thereafter, spirometry and questionnaire data should be collected periodically during a miner's employment. Testing with these modalities will allow the identification of those miners with possible early dust-related health effects.

NIOSH should share the findings of the medical surveillance data with MSHA.

A plan should be developed by NIOSH in consultation with MSHA to determine which cases should be followed-up considering, for example, the severity of findings, clustering of abnormalities and the potential for primary prevention. This plan should assure that the confidentiality of the miner is protected.

MSHA should examine the effectiveness of controls operating at work sites represented by these miners.

Miners identified with abnormal screening tests may benefit from appropriate secondary prevention efforts and appropriate miner education regarding the nature of mining-related lung diseases.

Medical testing of underground coal miners should be extended to surface miners.

RECOMMENDATION NO. 10

NIOSH should oversee the provision of confidential periodic medical examination programs for all mine workers including surface miners as specified above in order to achieve at least 85% participation rate. Participation should be promoted with adequate attention to the education of the miners and mine operators regarding the need for this program. The frequency of the periodic examination program should be at least that recommended by the NIOSH Criteria for a Recommended Standard, "Occupational Exposure to Respirable Coal Mine Dust".

In addition, NIOSH should specify performance standards for medical testing; collect data on medical testing, perform ongoing analysis of surveillance data as well as to locate "hot spots", perform field investigations when warranted by hot spots or other surveillance findings in conjunction with MSHA.

MSHA should mandate operator medical examination programs, and supply appropriate MSHA-collected exposure and employment data to NIOSH for surveillance purposes. In cooperation with NIOSH, MSHA should consider what additional exposure or employment data should be obtained from the operator to further the objectives of medical surveillance, and perform field investigations when warranted by hot spots or other surveillance findings.

Mine operators should pay for the mandated medical testing.

Miner participation should be improved by arranging convenient access to examinations, effective education about the purposes of the testing, timely notification of results of the testing, and maintenance of confidentiality. Additional benefit will be gained by promoting the development of effective and accurate exposure classification.

NIOSH should develop a program to track ex-miners and provide them with the same tests available to active miners. The appropriate frequency of such testing will need to be determined.

RECOMMENDATION NO. 11

The results of the Part 90 program should be systematically evaluated to determine its effectiveness. The surveillance data should be developed to allow appropriate comparison between those who do and do not exercise the Part 90 option. The comparison should consider the following: a) the health status as measured by initial and current chest x-ray, b) health status determined by earliest available and current pulmonary function (if any), c) current impairment or disability status, d) measured respirable dust exposure in jobs at time of Part 90 eligibility and in current job, and e) current employment status. These data should be organized for all miners as well as separately according to: a) geographic region (or type of coal and coal rank mined), b) size of mine (in terms of employment and in terms of tons of coal mined/quarter), c) type of mining (underground -- longwall, continuous, conventional -- versus surface), d) union status of miners, and e) age of miner. The annual rate of Part 90 eligibility should be examined by mine to determine whether specific mines experience *very* high or very low rates. The characteristics of such mines, if any, should be described in the terms noted in this recommendation.

The results of this evaluation of the Part 90 program should be organized and presented to an independent advisory committee for consideration of any recommendations for alteration of the program. Part 90 program characteristics that should be examined for change include: a) criteria for eligibility (degree of chest x-ray abnormality as well as criteria based on other health criteria such as pulmonary function), b) determination of adequate level of reduced dust exposure to prevent progression of abnormality, c) degree of protection of wage and seniority benefits, d) adequacy in process of informing miners of the Part 90 option and of the consequences of exercising or not exercising it in each specific case, and e) the training associated with dust control and its relationship to Part 90.

RECOMMENDATION NO. 12

MSHA should consider changes to assure that the training program is appropriately structured and staffed to carry out education and training functions related to dust control issues.
MSHA should conduct these activities in a manner that provides quality assistance to the mining industry and oversight of training programs. When cases of overexposure occur to respirable dusts, education and training personnel should be assigned to investigate possible failures in the education and training of miners and mining personnel at mines where these overexposures occur. In addition, MSHA should place high priority on filling the director of training position as soon as possible.

It is likely that adequate training cannot be delivered in the current time frames allowed to train, therefore, MSHA should review and consider restructuring as well as expanding its existing training programs to better meet the objective of a workforce with a comprehensive understanding of the potential long-term hazards of dust exposure, able to recognize dust sources and be effective partners with the operators in the routine maintenance of the dust control parameters.

MSHA should evaluate the content, duration, adequacy and methods of training for each content area. The evaluation must specifically include the adequacy of treatment of the following topics which should be included in initial training in addition to annual training.

- health hazards of respirable coal mine dust overall
- health hazards of respirable silica dust
- objectives and content of a model dust control plan
- the specifics of the dust control plan at the specific mine
- MSHA process for approval of dust control plan
- sources of dust generation
- control of dust sources
- dust control parameter ranges approved for the mine operations
- relative effectiveness of various dust control measures included in the plan
- mechanisms for reporting deficiencies and implementing corrective actions
- function and importance of monitoring exposure
- function and importance of medical surveillance, including local resources (e.g., company, NIOSH)
- how to review reports of exposure monitoring sources of additional information and assistance

The review should also include the methods of delivery; where not currently applied, proven, effective interactive methods of adult learning should be incorporated into program revisions.

Methods of evaluation of knowledge, skills and abilities gained from the training should be co s stent with adult learning objectives. A program for evaluation of the long-term impact of tramming should be developed and implemented.

The need for a specific, training program for operators/supervisors in addition to the above should be studied. Training topics might include:

the role of the foreman in the dust control plan
the implementation of the team approach to dust control
the hierarchy of controls

MSHA personnel responsible for monitoring respirable dust at mines should receive similar training as miners/supervisors. In addition, they need to be constantly educated and updated on dust control methods and how they are applied. Their training should include proper procedures on evaluating dust control parameters.

All affected miners and supervisors need to be educated on any changes to respirable dust control plans, as changes are made.

The resulting programs should be used by all certified trainers for training of miners and mine operators.

MSHA should serve as a resource for training materials for the certified trainers.

MSHA should explore ways in which inspectors, during their normal work detail, might function to improve understanding of the role of enforcement activities in control of dust and disease.

MSHA should review, revise, and update the program to train and certify persons for taking dust samples. MSHA should require annual update training for certification and maintenance for the purpose of keeping these persons up to date with sampling methods and regulations, and for maintaining their expertise. If certified persons do not perform their duties properly, MSHA should consider retraining and/or de-certification.

RECOMMENDATION NO. 13

Hazard surveillance guidelines should be developed with the assistance of NIOSH for use by operators in maintaining and improving dust controls. These guidelines should directly and effectively utilize sampling results and measures related to control of respirable dust. These guidelines should specifically identify any trends or exposure levels that indicate deteriorating or marginally adequate conditions. A report of these findings should be included in MSHA's report of respirable dust samples results provided to the operator and to the miners' representative, and alert them that there is a need for a systematic reexamination of the continued effectiveness of existing control measures.

Hazard surveillance guidelines should also be developed for ventilation plan parameters that are regularly reviewed. These should be designed to assist operators in early identification of adverse trends in the parameters that, if not corrected, may cause miners to be exposed to higher dust levels.

RECOMMENDATION NO. 14

MSHA should develop an initiative to ensure the protection of mine construction workers, contract drillers, and other contractor employees with respirable coal mine dust and silica exposures. This effort should include estimation of the types of contractors, number of workers at risk and their levels of exposure; exploration of means of assuring compliance with permissible exposure limits, the use of dust control plans, sampling and training; delineating responsibility of mine operators and contractors in protecting contractor workers; and implementation of compliance activities to protect this sector of mine workers. MSHA should also improve recordkeeping of exposure to dusts, occupational lung disease, and other hazards that occur to workers of construction and other contractors in order to prevent occupational disease and injury.

MSHA should work with NIOSH to expand medical surveillance to appropriate groups of mine contractor workers and to conduct research pertinent to preventing respiratory disease and respirable dust exposures in mine contractor workers.

MSHA should collaborate with OSHA in bringing similar attention to operations such as exploratory drilling, which fall under OSHA jurisdiction.

RECOMMENDATION NO. 15

MSHA's reliance on dust sampling for compliance should be based on an appropriate balance of personal, occupational, and environmental sampling.

RECOMMENDATION N0.16

a. MSHA should adjust the PELs to account for extended work weeks.

MSHA should develop a formal, targeting mechanism for more frequent sampling of mining sections, mining units, and operators found to have a history of noncompliance with the respirable dust standards or sampling procedures.

MSHA should explore innovative ways to enhance its presence in mines for compliance sampling.

The MSHA sample data forms should be reviewed to assure that there is adequate space for recording the operating parameters at the time of sampling. The actual parameters should be compared with those in the approved dust control plan as part of the review of results of each compliance inspection.

MSHA should revise the sampling method (e.g. flow rate) to be consistent with recently developed international standards.

A method should be provided to identify the miner on the sample data form.

MSHA should ensure that all respirable dust sampling technology, such as the new continuous monitors being developed, be designed tamper resistant to the maximum extent possible. Further, MSHA should develop education and training material to be delivered to the entire industry concerning the importance of maintaining such equipment in a tamper proof state along with the consequences for failure to do so.

b The Committee believes that any MSHA resource constraints should be overcome by mine operator support for MSHA compliance sampling. The Committee recommends that to the degree that MSHA's resources cannot alone serve the objective identified, resource constraints should be overcome by mine operator funding for such incremental MSHA compliance sampling. One means for obtaining this support could be a reasonable and fair operator fee, based on hours worked, or other equivalent means designed to cover the costs of compliance sampling. Any operator fee program should include an accountability system to ensure uniform applicability of the program throughout the industry. The fee should only be utilized for the specific purposes of required compliance sampling.

c. The Committee considers it a high priority that MSHA take full responsibility for all compliance sampling at a level which assures representative samples of respirable dust exposures under usual conditions of work. In this regard, MSHA should explore all possible means to secure adequate resources to achieve this end without adverse impact on the remainder of the Agency's resources and responsibilities. Compliance sampling should be earned out at a number and frequency at least at the level currently required of operators and MSHA. The miner's representative would be afforded the opportunity to participate in these inspection activities as provided in Section I03(f) of the Mine Act.

Operator compliance sampling in the interim should continue with substantial improvement to increase credibility of the program based on the Committee's recommendations.

d. MSHA should increase the number of samples collected by the Agency to determine compliance with respirable dust standards. MSHA should place major emphasis on the use of personal monitoring for determining compliance with PELs. However, MSHA should continue the practice of designated occupation sampling for determining noncompliance.

MSHA should change the compliance sampling program to allow use of single full shift samples for determining compliance.

e. MSHA should make no upward adjustment to the PELs to account for measurement uncertainty.

f. MSHA in conjunction with the Department of Labor Solicitors Office should review the current process for investigating and acting on respirable dust practices which result in unrepresentative respirable dust samples and should create a credible, adequately staffed program for such investigations.

g. Mine operators should continue to measure exposure to respirable dust for D0s, DWPs, and DAs compliance sampling as provided in 30 CFR 70, 71, and 90. Additionally, mine operators should sample as part of plan verification. Operator sampling at surface mines and surface areas of underground mines should be increased to bi-monthly sampling similar to the underground sampling program. Operators should also continue to be allowed to take samples for purposes other than determining compliance. These samples should be clearly identified in the mine such as by using color code.

Abatement of citations based on MSHA or operator samples should require the operators to sample on multiple shifts as currently required.

h MSHA should exercise more oversight on operators' sampling methods and management of samples including periodic audits of dust sampling programs.

Samples taken to determine noncompliance should be taken when production is sufficiently close to the "normal production shift." The production level should be 90 percent of the average production of the last 30 production shifts and MSHA should require the mine operator to maintain the appropriate records.

J. MSHA should adjust the PELs to account for extended work shifts.

RECOMMENDATION NO. 17

Continuous monitors for dust control parameters should be utilized to evaluate and assess the quality of dust control measures as a part of mine respirable dust control plans.

RECOMMENDATION NO. 18

MSHA should make public a report of the progress toward each of the recommendations provided in the report of the Advisory Committee. An interim report should be provided by September 1997 with a final report issued by September, 1998.

RECOMMENDATION NO. 19

a. Miners' participation in the interim operator dust sampling program should be increased to provide assurances that a credible and effective dust sampling program is in place. To that end, miners at each mine should select designated representatives who are employed at that mine for compliance sampling. Miners designated as representatives of the miners should be afforded the opportunity to participate in all aspects of respirable dust sampling for compliance at the mine. That participation would include protection against loss of pay as provided under Section 103([) of the Federal Mine Act.

b. Miners' representatives should have the right to participate in dust sampling activities that would be earned out by the employer for verification of dust control plans at no loss of pay. Miners' representatives should also have the right to participate in any activities involving any handling of continuous dust monitoring devices or the extraction of data from continuous dust monitoring devices without loss of pay.

c. Miners' representatives should receive training and certification to conduct respirable dust sampling paid by the employer. Miners' representatives should be afforded the opportunity without loss of pay from the mine operator to participate in the training of the miners.

d. A description of work activities and dust exposures on sampling days would be provided to the affected miners by those taking the dust samples.

e. Miners being sampled should receive in writing by mine operators data on their dust exposure along with any pertinent information on the sampling activities and dust control parameters/production rate, etc. once the sample is analyzed. Written data on the dust exposure of miners being sampled along with any pertinent information on the sampling activities and dust control parameters/production rates should be posted on the mine bulletin board.

f The Committee recognizes the problem of miner representation and participation in the dust control programs at mines not represented by a recognized labor organization and recommends that MSHA target such mines for compliance sampling. MSHA targeting should be active in nature and should consider many factors including miner input, compliance history, and medical surveillance data. Given the seriousness of this problem, MSHA should immediately start auditing and appropriately targeting these types of operations.

RECOMMENDATION NO. 20

The NIOSH Criteria Document lists research needs pertinent to coal miner respiratory health and prevention of disease in the following areas: engineering control methods, respiratory protection, sampling devices, sampling strategy, medical screening and intervention, adverse health effects of dust exposure, characterization of dust, and training and education. The primary focus of NIOSH with regard to the prevention of CWP needs to be ongoing analysis of the medical surveillance program data for hot spots, in order to direct primary prevention efforts where they are most likely to be of direct and immediate benefit to miners. To the degree that research activities do not take precedence over or detract from resources devoted to meaningful administration of the medical surveillance program, the Committee concurs with these research needs. The Committee recommends increased funds for research into fundamental and applied aspects of respirable dust control as well as health effects research. In addition to those listed by NIOSH, some Committee members believe that the following specific research should be undertaken in areas pertinent to MSHA responsibilities:

A. Medical and Epidemiologic Research

MSHA should collaborate with NIOSH in assessing long-latency health effects and their risk relationships with quantitative dust exposure estimates in miners who have left the industry.

MSHA should collaborate with NIOSH in research on respiratory health in construction and contract workers with worrisome exposures to respirable coal mine and silica dusts to serve as the basis for continued policy recommendations.

The efficacy and economics of high-resolution computerized tomography (HR. CT) as a routine confirmatory test in surveillance of coal miners.

Among risk factors already identified by NIOSH in their Criteria Document, coal rank should also be a consideration.

The relative degree of pathology and dust loading in the lungs of deceased miners in the autopsy program, comparing miners who started mining subsequent to 1972 with those with pre-1972 coal mine dust exposure.

MSHA in collaboration with NIOSH should evaluate the impact of silica exposures on adverse health effects among miners, including silicosis among surface miners.

B. Research on Mechanisms of Coal Mine Dust, Generation, and Control

Research is needed to enhance our understanding of the influence of geology and seam characteristics on respirable coal mine dust generation and physical characteristics of coal mine dust needed for development of control technology.

Applied research to enhance the fundamental understanding of coal mine dust generation, entrainment, transport and capture mechanisms.

C. Applied Engineering Control Research

Development of more effective mine dust (including quartz) control systems for modem high production longwalls. These might include new cutting mechanism and tools to reduce dust generation, use of operation practices (face/out-by haulage, headgate cut-out, sprays) to reduce entrainment or use of air distribution systems which create two splits of air (face split, walkway split) along the longwall face to contain dust in the facearea.

Development of improved dust control systems for continuous mining units which might include ventilation/spray systems for containing dust to the face area in continuous miner sections and enhance their capture and improved scrubbers for application in continuous-miner sections (higher collection efficiency).

Assessment of sources of dust exposure and dust levels in new mining systems or new mining technology (e.g., continuous miner, diesels, etc.) and development of appropriate control technology.

Development of new technology for airborne dust control utilizing surfactants, change sprays, foams, etc.

D. Dust Sampling Methods and Surveillance

MSHA in collaboration with NIOSH should analyze available data on sampling and dust exposure conditions to identify a sampling strategy that assures representative characterization of respirable dust exposures under usual conditions of work. The strategy should include the number of samples and frequency of sampling in order to provide accurate and unbiased estimates of exposures.

Development of sampling instruments and sampling methodology for continuous monitoring of personal and area exposures.

Assessment of the relationships between personal, area and environmental sampling, and time-averaged and continuously monitored concentrations.

MSHA and the USBM must test and characterize reliable tamper resistant respirable dust monitoring devices that would provide real time information on the mine dust levels and record the actual concentrations over several days. The devices need to be developed for person-wearable use, as well as environmental monitoring on machines and in areas.

E. Information and Training

MSHA and the former USBM should evaluate the effectiveness of techniques of technology transfer. MSHA and the former USBM must develop a program to disseminate to the mining industry, and MSHA personnel responsible for respirable dust plan evaluation and approval information on the various methods of respirable dust control. Additionally, MSHA needs to insist on the implementation of such controls where applicable to control respirable dust as part of mine plan approval.

MSHA, in conjunction with NIOSH, should conduct research regarding the impact of training and effectiveness of different training techniques, which could be used to strengthen training program content and delivering/evaluation methods.

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NEW MINE DUST STANDARD RULE

The U.S. Mine Safety and Health Administration (MSHA) has mandated that underground and surface coal mine operators must reduce the allowable exposure of respirable coal dust from 2.0 to 1.5 milligrams per cubic meter of air over a full work shift. This and other new requirements are part of a final rule MSHA says represents the most significant changes to dust-control practices in coal mines since the 1969 Coal Mine Safety and Health Act.

The final rule, "Lowering Miners' Exposure to Respirable Coal Mine Dust, Including Continuous Personal Dust Monitors," was issued on April 23, 2014. The rule became effective August 1, 2014, with a two-year phase-in period for some provisions. The new and expanded requirements cover 568 active underground coal mines and 1,303 active surface coal mines (as of 2013), according to MSHA. Underground mines in the United States employed 48,504 miners in 2013, and surface mines employed 30,705 miners, according to MSHA.

Surface coal mine operations are subject to exposure limits and medical surveillance provisions for the first time under the rule. Both surface and underground coal mines must meet the new exposure limits, take immediate action when dust levels are high, and provide expanded medical surveillance of miners. Use of continuous personal dust monitors will be required for underground coal mines on February 1, 2016, and will be optional for surface coal mines.

The new MSHA rule adds spirometry testing to the existing chest x-ray examination program for both underground and surface coal mine workers. The Centers for Disease Control and Prevention's (CDC) National Institute for Occupational Safety and Health (NIOSH) is responsible for implementing the expanded health surveillance program.

For new miners (who never worked in a coal mine before August 1, 2014), a surface or underground mine operator must provide medical surveillance within 30 days of the miner beginning employment, an initial follow-up examination within three years, and a second follow-up examination if the initial follow-up indicates any decreased lung function or indication of lung disease.

In addition, for miners employed before August 1, 2014, a mine operator must provide the opportunity to have a medical exam at least every five years that includes an x-ray and spirometry, as well as a symptom assessment and occupational history questionnaire. An operator must provide the medical exams at no cost to miners, and must use a facility approved by NIOSH to provide the examinations.

Chronic exposure to respirable coal dust causes lung diseases that can lead to permanent disability and death, according to MSHA. In the decade 1995-2004, more than 10,000 miners died from black lung disease, sometimes called "coal worker's pneumoconiosis." The disease typically builds up over long periods of time and can damage a miner's ability to breathe. There are no specific treatments to cure black lung disease, and the chronic health effects may progress even after miners are no longer exposed to respirable coal mine dust. MSHA's new rule aims to prevent the exposures that lead to black lung and other lung diseases—which include emphysema, silicosis, and chronic bronchitis. Other complications may follow, such as pulmonary and cardiac failure.

"Anyone who thinks black lung is a thing of the past is dead wrong," says MSHA chief Joseph Main. NIOSH estimates that more than 76,000 miners have died since 1968 as a result of the disease.

Chest x-rays alone cannot provide a measure of airflow obstruction, and often miss important lung disease, such as chronic obstructive pulmonary disease (COPD), according to MSHA. Spirometry, a simple breathing test, is a "particularly useful additional component of the health assessment of miners," says MSHA.

However, pathologic changes occurring during the subclinical stage of disease development are not detectable by either spirometry or chest x-ray, according to MSHA. For this reason, MSHA says that all miners should have an initial medical exam to establish a baseline health status on which follow-up medical exams can be compared to determine disease presence or progression. MSHA's 2014 final rule gives both underground and surface miners who have evidence of pneumoconiosis transfer rights—they can elect to work in less dusty atmospheres to prevent progression of the disease.

Many miners do not report overt symptoms of black lung in the early progression of the disease. Later, workers may report symptoms of developing respiratory disease, such as chronic cough, phlegm production, wheezing and shortness of breath.

Results of examinations and tests under the medical surveillance requirements are not provided to the mine operator. They may only be provided to the U.S. Secretary of Labor, the U.S. Secretary of Health and Human Services, and, at the request of the miner, to the miner's designated physician.

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APPENDIX J

Summary of Votes Cast by Members of the Advisory Committee on the Elimination of Pneumoconiosis among Coal Mine Workers

	DR WEGMAN	DR KREISS	DR RICE	DR DEMENT	DR RAMANI	DR GIBBS	MR LAMONICA	MR MAIN	DR WEEKS	AF/OP/AB
REC 1	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 2	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 3	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 4	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 5	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 6	AFFIRM	AFFIRM	AFFIRM	AFFIRM	ABSTAIN	OPPOSE	OPPOSE	AFFIRM	AFFIRM	6/2/1
REC 7	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 8	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 9	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 10	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 11	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 12	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 13	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 14	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 15	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	OPPOSE	OPPOSE	AFFIRM	AFFIRM	7/2/0
REC 16 a	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 16 b	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	ABSTAIN	AFFIRM	AFFIRM	8/0/1
REC 16 c	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 16 d	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	OPPOSE	OPPOSE	AFFIRM	AFFIRM	7/2/0
REC 16 e	AFFIRM	AFFIRM	ABSTAIN	AFFIRM	OPPOSE	OPPOSE	OPPOSE	AFFIRM	AFFIRM	5/3/1
REC 16 f	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	ABSTAIN	AFFIRM	AFFIRM	AFFIRM	8/0/1
REC 16 g	AFFIRM	AFFIRM	ABSTAIN	AFFIRM	OPPOSE	OPPOSE	OPPOSE	AFFIRM	AFFIRM	5/3/1
REC 16 h	AFFIRM	AFFIRM	AFFIRM	AFFIRM	ABSTAIN	AFFIRM	AFFIRM	AFFIRM	AFFIRM	8/0/1
REC 16 i	AFFIRM	AFFIRM	AFFIRM	AFFIRM	OPPOSE	OPPOSE	OPPOSE	AFFIRM	AFFIRM	6/3/0
REC 16 j	ABSTAIN	ABSTAIN	ABSTAIN	ABSTAIN	AFFIRM	OPPOSE	OPPOSE	AFFIRM	AFFIRM	3/2/4
REC 17	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 18	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 19 a	AFFIRM	AFFIRM	AFFIRM	AFFIRM	ABSTAIN	OPPOSE	OPPOSE	AFFIRM	AFFIRM	6/2/1
REC 19 b	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	ABSTAIN	OPPOSE	AFFIRM	AFFIRM	7/1/1
REC 19 c	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	OPPOSE	OPPOSE	AFFIRM	AFFIRM	7/2/0
REC 19 d	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 19 e	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
REC 19 f	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	OPPOSE	OPPOSE	AFFIRM	AFFIRM	7/2/0
REC 20	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	AFFIRM	9/0/0
AF/OP/AB	33/0/1	33/0/1	31/0/3	33/0/1	28/3/3	23/9/2	22/11/1	34/0/0	34/0/0	

Attachment
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Federal Mine Safety & Health Act of 1977, Public Law 91-173, as amended by Public Law 95-164*

(f) Subject to regulations issued by the Secretary, a representative of the operator and a representative authorized by his miners shall be given an opportunity to accompany the Secretary or his authorized representative during the physical inspection of any coal or other mine made pursuant to the provisions of subsection

(a), for the purpose of aiding such inspection and to participate in pre- or post-inspection conferences held at the mine. Where there is no authorized miner representative, the Secretary or his authorized representative shall consult with a reasonable number of miners concerning matters of health and safety in such mine. Such representative of miners who is also an employee of the operator shall suffer no loss of pay during the period of his participation in the inspection made under this subsection. To the extent that the Secretary or authorized representative of the Secretary determines that more than one representative from each party would further aid the inspection, he can permit each party to have an equal number of such additional representatives. However, only one such representative of miners who is an employee of the operator shall be entitled to suffer no loss of pay during the period of such participation under the provisions of this subsection. Compliance with this subsection shall not be a jurisdictional prerequisite to the enforcement of any provision of this Act.

Attachment
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Coal Mine Safety: Do Unions Make a Difference?

Alison D. Morantz‡

ABSTRACT:

Although the United Mine Workers of America (UMWA) has always advocated strongly for miners' safety, prior empirical literature contains no evidence that unionization reduced mine injuries or fatalities during the 1970s and '80s. This study uses a more comprehensive dataset and updated methodology to examine the relationship between unionization and underground, bituminous coal mine safety from 1993 to 2010. I find that unionization predicts a substantial and significant decline in traumatic injuries and fatalities, the two measures that I argue are the least prone to reporting bias. These disparities are especially pronounced among larger mines. My best estimates imply that overall, unionization is associated with a 13-30% drop in traumatic injuries and a 28-83% drop in fatalities. Yet unionization also predicts higher total and nontraumatic injuries, suggesting that injury reporting practices differ between union and nonunion mines.

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Empirical literature on the relationship between unionization and workplace safety presents a curious puzzle. On one hand, lscholars have documented numerous ways in which unions help to promote safe work practices. For example, unions typically play a critical role in educating workers about on-the-job hazards; incentivizing workers to take greater care on the job; attracting more safety-conscious workers; inducing employers to abate known hazards; increasing regulatory scrutiny; and developing safety-related innovations. Yet most empirical studies of the relationship between unionization and important safety outcomes, such as injuries and fatalities, have failed to find statistically significant evidence of a "union safety effect" (Morantz 2009).

Prior research on the coal mining industry typifies this perplexing pattern. Coal miners' unions, especially the dominant United Mine Workers of America (UMWA), have advocated vigorously for improved worker safety since their inception. When the UMWA adopted its first constitution in 1890, for example, three of its "Eleven Points" called for improvements in the safety and health conditions of miners (Fox 1990:22-25). Organized labor was also instrumental in the passage of the Mining Safety and Health Act of 1969 (the "Coal Act"), the statute that paved the way for comprehensive federal enforcement of occupational safety regulations at all surface and underground coal mines (Fox 1990:470-73). More recently, the UMWA played a critical role in broadening the provisions of the Coal Act and encouraging the formation of state regulatory agencies (Fox 1990:462-470, 474, 504). By the 1980s, the UMWA's Health and Safety Department had developed an extensive tripartite structure including a Washington, D.C.-based international staff; regionally-based health and safety representatives tasked with liaising with Mining Safety and Health Administration (MSHA) District Offices; and mine-level health and safety committees that surveil day-to-day mine conditions. The myriad activities of mine-level health and safety committees include advocating on behalf of individual miners; conducting independent inspections; accompanying MSHA inspectors during inspections; participating in pre- and post-inspection meetings; tracking MSHA appeals; providing various forms of safety training; and, in extreme cases, shutting down hazardous sections of a mine, a power conferred by the UMWA's collective bargaining agreement with the Bituminous Coal Operator's Association (BCOA) (Weil 1987: 117). Nevertheless, most empirical studies focusing on the 1970s and '80s have reported, if anything, a counterintuitive *positive* relationship between a union's presence at a mine and the frequency of reported injuries and accidents.

This paper re-examines the link between unionization and mine safety using more recent data, a broader set of control variables, and updated statistical techniques. Highly granular MSHA data on injuries and mine characteristics, combined with data from the National Institute for Occupational Safety and Health (NIOSH) and confidential data obtained from the Department of Energy, enable me to examine whether several discrete safety outcomes differ significantly between union and nonunion mines. Focusing on underground mines that extract bituminous coal, I find that unionization is robustly associated with lower levels of traumatic injuries and fatalities, the two safety outcomes that I argue are the least prone to reporting bias. My best estimates imply that overall, unionization predicts a 13-30% drop in traumatic injuries and a 28-83% drop in fatalities.[1] These effects are especially pronounced among larger mines and, for traumatic injuries, after the mid-1990s. At the same time, however, unionization is associated with a significant *increase* in total and non-traumatic injuries, measures that are highly susceptible to reporting bias. Taken together, these findings lend credence to concerns that injury reporting practices vary significantly across union and nonunion settings.

Literature Review

In the past few decades, scholars have examined the relationship between unions and workplace safety in a wide range of industries, such as the U.S. construction sector (Dedobbeleer, Champagne, and German 1990), U.S. manufacturing (Fairris 1995), British manufacturing (Reilly, Paci, and Holl 1995, Nichols, Walters, and Tasiran 2007), forest product mills in British Columbia (Havlovic and McShane 1997), and the New Jersey public sector (Eaton and Nocerino 2000). Most such studies have failed to find a statistically significant negative relationship between unionization and the frequency of workplace accidents. Similarly, empirical scholarship relying on aggregate cross-industry data from the U.S., Canada, and Great Britain has rarely reported any robust evidence of a salutary union effect. (Morantz 2009).

Given its inherent dangers, the mining sector has attracted a disproportionate share of scholarly attention. Several recent historical studies suggest that if anything, unions improved miners' safety during the early twentieth century (Fishback 1986; 1987:324; Boal 2009). However, empirical scholarship focusing on the decades after the passage of the Coal Act (1969)

[1] These ranges represent 95% confidence intervals for the coefficients on the "union" indicator variables in the public-fields version of the baseline (hours worked) specification presented in Table 2.

has reached very different conclusions. Boden (1977:116) and Connerton (1978), the first two empirical studies focusing on the latter part of the twentieth century, examine data from 1973-75 and 1974-75, respectively. Although neither study focuses specifically on unionization, both include union status as a control variable and report that union mines experienced significantly more disabling injuries, *ceteris paribus*, than their nonunion counterparts. A landmark study on underground coal mines sponsored by the National Research Council (1982), examining data from 1978-80, also briefly addresses the relationship between unionization and mine safety. The authors observe that the positive statistical relationship between union status and disabling injuries disappears when they confine attention to a measure of injuries that is less prone to reporting bias than total injuries, and that a (negative) correlation between unionization and mine fatalities also vanishes when one accounts for mine size.[2] On these grounds, the authors suggest that there is no relationship at all between unionization and underground coal mine safety (NRC 1982:95-96).

Appleton and Baker (1984), the first study to focus squarely on the effect of union status, analyzes cross-sectional data from a single year (1978) culled from 213 mines in eastern Kentucky and western Virginia. Controlling for several mine-specific covariates, the authors report that both total injuries and relatively serious injuries are significantly higher at union mines. They hypothesize that the union job-bidding system and/or union miners' postulated lower job motivation and productivity could explain these results. Several later commentators (Bennett and Passmore 1985; Weeks 1985) critique Appleton and Baker's conclusions by pointing out limitations in their data and methodology.

In sum, scholars have generally reported a *positive* relationship, if any at all, between union status and reported mining inuries since the New Deal. There are, however, several

[2] "Intermediate" injuries, adjudged by the study's authors to be the least prone to reporting bias, are defined to comprise "all fatal and permanent disability injuries as well as all injuries resulting from roof/side falls, machinery, haulage, or electrical/explosive accidents" (NRC 1982:82). The report states, "The rationale for defining [the intermediate injury rate] rested on the belief that reporting inconsistencies would occur most frequently for the degree 3-5 material handling and slipping/bumping injuries. Consequently, for consistency in reporting, [the intermediate injury rate] is felt to lie somewhere between the [fatality and permanent disability rate], where reporting differences are felt to be negligible, and the [disabling injury rate], where they might not be. We thus regard [the intermediate injury rate] as a compromise measure of safety that includes ample numbers of injuries for most statistical purposes and provides for reasonably good consistency between mines in the reporting of injuries" (NRC 1982:83-84). As a robustness check, this paper's *Companion Website* (http://amorantz.stanford.edu/papers/union-coal-mine-safety/) reports results from models in which the dependent variable is the number of intermediate injuries. Although the estimated coefficients are not dissimilar from those presented for traumatic injuries in Table 2, none is statistically significant at the 5% level.

compelling reasons to question the accuracy and contemporary relevance of these findings.

First, as Appleton and Baker (1984:140) point out, the accident reporting system in use before 1978 suffered from extremely poor reporting practices, and therefore underreporting of injuries by nonunion mines could have biased the results of Boden (1977) and Connerton (1978).

Second, most prior scholarship relies upon data that is geographically restricted, highly aggregated, time-invariant, and/or prone to small-sample bias. For instance, the 213 mines analyzed in Appleton and Baker (1984) were restricted to a single geographic region and comprised less than 10% of all coal mines that were active in 1978.

Third, all of the statistical analysis in prior studies consists of ordinary least squares regression modeling. Under standard assumptions, Poisson and negative binomial models yield less biased estimates, and therefore have become the preferred approach for analysis of "count data" such as injuries and fatalities (Cameron and Trivedi 1998:1-3).

Finally, the labor strife that characterized most of the 1970s, which included periodic strikes and work stoppages, may have limited unions' capacity to improve safety practices. Although Appleton and Baker limit their study of bituminous mining to what they characterize as a single "non-strike year" (1978) in the hopes of circumventing this problem, government statistics indicate that 414 bituminous coal mine strikes took place in 1978 and that the national labor-management climate remained highly adversarial (Staats 1981: 12-25; Darmstadter 1997: 27-31). Moreover, even if unions were relatively ineffectual during the 1970s, their impact may have changed in recent decades, as the UMWA become more familiar with MSHA's regulatory procedures and expanded the scope of its internal health and safety programs (Weil 1994: 197).

In short, analysis of recent data may not only bear more directly on unions' contemporary relevance, but may also yield more credible estimates of their long-term effect. To my knowledge, no study has directly investigated the relationship between unionization and mine safety since 1980.[3]

The goal of the present article is to fill this gap in the literature by examining the 1993-2010 period with comprehensive, granular data and up-to-date econometric methods. I pose, in turn, a series of questions regarding the relationship between unionization and mine safety during this period. First, are there statistically significant disparities, *ceteris paribus*, between the rates

[3] Reardon (1996) analyzes coal mining data from 1986-88, but he does not compare the probabilities of accidents occurring across union and nonunion settings. Rather, he focuses on the probability that a *reported accident* has already resulted (or will likely result) in a fatality or permanently disabling injury.

of occupational injuries in union and nonunion coal mines? Second, do such disparities persist if one focuses on measures of injury rates that are relatively impervious to reporting bias? Third, have the disparities remained constant, or have they fluctuated over time? Finally, what might explain these empirical findings?

Data

The analysis presented here relies primarily on MSHA's historical database from 1993-2010. This database includes quarterly data on the characteristics of each coal mine under MSHA's purview and on each accident or injury that was reported to MSHA during this period. Although enormously detailed, the dataset has two important limitations. First and foremost, it contains little information on the union status of individual mines. Although MSHA originally collected data on unionization, the survey fell into disuse by the 1990s and historical records on union status were not preserved.[4] In 2007 MSHA conducted a one-time survey of mines in an effort to identify which ones were operating under union contracts, and in what year those mines became unionized. Using these data, one can obtain a snapshot of the union status of U.S. mines in 2007. However, it is impossible to determine whether any given mine was unionized in prior years and, if so, for how long. Secondly, although the MSHA database contains comprehensive data on coal production and employment, it lacks information on each mine's geological characteristics (such as mean coal bed thickness), economic constraints (such as whether it is a subsidiary of a larger firm), and predominant extraction methods (such as the relative prevalence of longwall, shortwall, continuous, and conventional mining).

To remedy these shortcomings, I supplement the MSHA database with information obtained from NIOSH and the Department of Energy's Energy Information Administration (EIA). The EIA database encompasses every mine in the U.S. that produces an appreciable amount of coal.[5] Most importantly for my purposes, the EIA database contains a "union ID" field indicating whether each mine was unionized in a given year and, if so, by which union.[6]

[4] Phone conversation with MSHA's George Fesak, Director of Program Evaluation and Information Resources, on 8/14/08.

[5] According to the EIA Coal Production and Preparation Report (Form EIA-7A), the EIA collects data annually on mines with operations that "produced and/or processed 10,000 or more short tons of coal and/or worked 5,000 hours or more during the reporting year." Of our sample (from MSHA) of underground, bituminous coal mines with active production for the years 1993-2010, 0.41% of mine-years do not have corresponding EIA data. These observations were dropped from the dataset.

[6] The EIA considers this data unreliable prior to 1993 (Phone Conversation with Vlad Dorjets, Lead Economist at

The data also contain detailed information on the geological and economic characteristics of each mine, including the number of coal beds, the thickness of each coal bed, the value of captive and open production, productive capacity, recoverable reserves, and (for underground mines) the share of production attributable to conventional, continuous, longwall, shortwall, and other mining methods.[7] Finally, the NIOSH dataset contains an alternative (binary) measure for whether or not a mine utilizes longwall mining.[8] Merging the MSHA, EIA, and NIOSH datasets allows me to assemble a detailed picture of safety-related outcomes at each union and nonunion coal mine in the country between 1993 and 2010. (Precise definitions of the variables included in this final dataset, along with their respective sources, are presented in Appendix C.)

I restrict the sample in several ways to ensure that the attributes of the union and nonunion mines being compared are as similar as possible.[9] First, like most previous scholars, I confine my analysis to underground coal mines. (Surface coal mines, which have very different risk profiles and production characteristics, are also much less likely to be unionized.) Secondly, since none of the underground anthracite and lignite coal mines in the dataset operated under a union contract, I restrict the sample to bituminous coal mines. Third, I drop any mine-quarters in which a mine reported zero coal production and/or zero hours worked.[10]

Once these restrictions are imposed, the final sample contains 2,635 mines,[11] each of

EIA, on 2/25/2010). Since the EIA's union data are reported annually, whereas MSHA's injury data are reported quarterly, I make the simplifying assumption that the union status recorded for a particular year applies to all four quarters of that year.

[7] Since some of these variables are considered trade secrets by the mines that provide them, I obtained these data on a confidential basis. EIA staff indicated that two of these variables, recoverable reserves and percent captive production, are unreliable before 1998 (E-mail correspondence with William Watson, EIA, 12/7/2010). Results including these confidential fields are presented in the "confidential-fields" specifications for 1998 onwards.

[8] Because of the uncertainty surrounding which way of coding each mine's extraction method is more accurate – the multifaceted approach used by MSHA, or the binary approach used by NIOSH – I estimate models that include (respectively) each measure as a regressor.

[9] As a robustness check, I refine the sample further using matching methods and re-estimate the models. The purpose of this procedure, as described by Ho et al. (2007), is to balance the distributions of the covariates across the "treatment" and "control" groups. The "balanced" sample consists of 11,378 mine-quarters for which the estimated likelihoods of unionization are similarly distributed across the union and nonunion subsamples. Although results for this sample, available on the *Companion Website* (http://amorantz.stanford.edu/papers/union-coal-mine-safety/), generally echo those presented in the Results section, all of the coefficients in the fatality models lose statistical significance.

[10] While injuries occur occasionally when a mine is not producing coal, the underlying causes of such accidents are likely to differ from those that occur during active production. Out of 42,586 initial mine-quarters, 3,696 (8.7%) reported zero coal production and/or zero hours worked; these were dropped from the analysis.

[11] Because a mine that is unionized for part of the sample period and nonunionized for part of the sample period is counted in Appendix Table A1 as both a union mine and a nonunion mine, some mines are double-counted, for a total of 2,799 mines. The total number of mines used in the baseline regressions is 2,635. The difference between these two numbers, 164 mines, represents the number of mines that switched union status at some point during the

which was active, on average, for 15 of the 72 quarters under observation.[12] Figure 1 shows the geographical distribution of the mines in the sample. While the mines are spread across 17 states, 89% are located in the coal mining regions of Kentucky, Pennsylvania, West Virginia, and Virginia. Figure 2 displays the percentage of active mines that were unionized in each quarter. Mirroring the general trend for most U.S. industries, the unionization rate declined steadily, from 18.7% in 1993 to 9.2% in 2010.

Each injury report submitted to MSHA contains information on the nature and source of the injury, the body part(s) affected, the activity in which the employee was engaged when the incident occurred, and the severity of the injury (ranging from "first aid" to "fatality"). Using these fields, I tabulate four different injury counts: fatal injuries ("fatalities"), "traumatic" injuries,[13] "non-traumatic" injuries,[14] and total injuries. For each tabulation, I include only injuries that occurred in the underground subunit of a mine.[15] Table 1 presents injury counts (and percentages) for both union and nonunion mines. Although fatalities uniformly comprise a very

sample period. The latter group of 164 mines comprises the sample in the fixed effects models in Appendix Table A3. Also, because the historical variables (lost-work injuries and penalty points) are summed up for the previous four *quarters* for the non-traumatic, total, and traumatic injuries regressions, but are summed up for the previous *calendar year* for the fatality regressions, some mines are excluded from the fatality models but included in the other models. (For example, if a mine is open for all of only one calendar year, it will have no historical data at the *yearly* level, but it will have historical data for three of the four *quarters* it was open.) For this reason, the sample used for the fatality models contains only 2,568 mines.

[12] The underground coal mining industry exhibits high rates of entry and exit due to fluctuating demand and costs of production. For example, out of 884 mines that were active in the first quarter of 1993, only 16% were still active in the first quarter of 2000 and only 6% remained active in the final quarter of 2010. Similarly, out of 421 mines that were active in the final quarter of 2010, only 22% had been active in the first quarter of 2000, and only 11% had been active in the first quarter of 1993.

[13] Because a "traumatic" injury, by definition, is caused by a discrete accident that a miner sustains during working hours, its work-relatedness is rarely in dispute as long as the miner's account of the incident is deemed credible. In contrast, the diagnosis of non-traumatic injuries, such as cumulative or repetitive-motion injuries, often relies on the patient's self-report of subjective symptoms. Because the existence – let alone the work-relatedness – of the latter injuries may be difficult to verify using "evidence-based medicine," the frequency with which such claims are filed and approved can vary widely across employers. The category of "traumatic" injuries, intended to encompass the subset of injuries that are the least prone to underreporting, was defined in consultation with Professor Mark Cullen, M.D., the Chief of Stanford University's Division of General Internal Medicine. According to Dr. Cullen, the critical determining factor in determining whether or not an injury is reported is not the triggering *cause* of the injury, but rather the characteristics of the injury itself. More specifically, injuries of at least moderate severity, whose effects are readily visible, that are "traumatic" (rather than cumulative) in nature are generally the least prone to reporting bias. The following injuries were deemed by Dr. Cullen to meet these criteria: amputations; enucleations; fractures; chips; dislocations; foreign bodies in eyes; cuts and lacerations; punctures; burns/scalds; crushings; and chemical, electrical, and laser burns. Fatalities of any type are also treated as traumatic injuries. So defined, "traumatic" injuries account for 37.5% of the injuries reported during the period of observation.

[14] All injuries that are not classified as "traumatic" injuries are classified as "non-traumatic" injuries.

[15] As a robustness check, I also estimate models that include *all* injuries occurring at underground mines, including those that take place above ground. Presented on the *Companion Website*, these results do not materially change my findings.

small fraction (0.3-0.6%) of total accidents, the fraction of non-traumatic injuries is typically higher at union mines than at nonunion mines (69.9% versus 58.1%).

Figure 3 provides a preliminary comparison of recent trends across union and nonunion mines by plotting, respectively, the frequencies of total and traumatic injuries (per 2,000 hours worked) from 1993 to 2010. Two general patterns are apparent. First, regardless of union status, the frequency of traumatic injuries has remained relatively constant over time, whereas the frequency of total injuries has declined steadily since the early 1990s. Secondly, although the direction and magnitude of the union-nonunion disparity fluctuated by year and injury type in the early 1990s, by the turn of the millenium, union mines were reporting lower injury rates than nonunion mines regardless of the metric examined.

Methodology

To explore the relationship between union status and safety outcomes, I estimate negative binomial regression models in which the dependent variables are, respectively, total injuries, non-traumatic injuries, traumatic injuries, and fatalities.[16] The total number of hours worked is used as an exposure term, and standard errors are clustered at the mine level. In addition to a dummy variable indicating the presence of a union, I include several other covariates (listed in the Appendix) that, based on prior literature and/or conversations with industry stakeholders, are deemed likely to affect mine safety. This article presents results from several leading models. Two different versions of three model specifications were estimated, for a total of six specifications. The two versions differ in that the "public-fields" version relies solely on public data, whereas the "confidential-fields" version incorporates confidential data from EIA.[17] The first model specification uses full-time equivalents (FTEs)[18] as the measure of mine size. Since it is conventional to use FTEs to calculate the frequency of workplace accidents, this is designated as the "baseline" specification, as in Morantz (2012). The second and third specifications use employees[19] and coal tonnage[20] as alternative measures of mine size.

[16] Tests of overdispersion consistently indicate that a negative binomial model is preferable to a Poisson model.
[17] See Appendix B for a complete description of model specifications.
[18] Yearly FTEs are defined as 2,000 hours worked, and quarterly FTEs are defined as 500 hours worked.
[19] MSHA defines employees as the average number of persons working during each pay period of a given quarter, rounded to the nearest whole number (see http://www.msha.gov/stats/part50/rptonpart50.pdf). Results presented here include only employees working in the underground subunit. On the *Companion Website*, I present results from a robustness check in which I include all injuries at underground mines, regardless of whether the injuries occurred

Several studies by Weil (1987:181-84; 1991:23; 1992:124-25) suggest that unions' effects on workplace safety vary by employer size. For example, unions at large and small facilities may differ in their respective capacities to exercise their "walk around" rights during MSHA inspections; to form powerful health and safety committees; to independently conduct inspections; and to enforce open-door policies among safety and health personnel. To explore whether unions' impact varies by mine size, I fit several models including interaction terms between union status and mine size quartiles.

The final public-fields specification includes the following regressors: union dummy, mine size, union-size interaction term(s), logged controller size, mine age, mine productivity, number of lost-work injuries (in hundreds) in the previous four quarters (or in the previous year for fatality regressions), total penalty points (in thousands) in the previous four quarters (or in the previous year for fatality regressions), a constant term, dummies indicating presence of each type of mine subunit, quarter dummies, MSHA district dummies, and a longwall indicator. The confidential-fields version replaces the longwall indicator with mining method percentages and adds as regressors the number of coal beds, mean coal bed thickness (in yards), subsidiary indicator, captive production as a percentage of total production, and recoverable coal reserves. Appendix Table A1 presents descriptive statistics for each included covariate.

For total, traumatic, and non-traumatic injuries, I use the most granular time period available, the "mine-quarter," as the unit of analysis. However, because fatalities are such rare events, using quarterly data is problematic when modeling fatality counts. (There is often too little variation across observations to yield valid estimates.) Therefore, I use the "mine-year" as the unit of analysis in all fatality regressions.

By including a broader set of covariates than has been used in previous studies, I hope to minimize omitted variable bias. Nevertheless, there are several potentially confounding characteristics of union and nonunion miners – such as disparities in miners' demographics and remuneration levels – for which I cannot control. These limitations, including their implications for the interpretation of my findings, are discussed in the Interpretation section.

Other types of unobservable, mine-level heterogeneity could also bias my analysis. For

above or below ground. For purposes of these models, I consider all employees in the mine – not just those working in the underground – when calculating mine size.

[20] Tonnage is defined here as the total tons of coal produced in the underground subunit of a mine. On the *Companion Website*, I present robustness checks in which all injuries (regardless of subunit) are included in the model; for these purposes, I similarly define tonnage as total tons produced across all subunits.

example, unusually hazardous geological conditions may affect a mine's injury rate as well as the likelihood that its employees will vote for unionization. In theory, a promising way to control for unobservable heterogeneity across mines is to use (mine-level) fixed effects to explore whether a given mine's safety record changes in predictable ways when it ceases (or begins) operating under a union contract. In practice, however, estimating fixed-effects models in this context creates more identification problems than it solves. First, only a handful of underground coal mines (6.2%) changed union status during the period examined. Second, these mines are highly unrepresentative of the population as a whole.[21] Any identification strategy predicated upon this idiosyncratic subgroup would likely yield biased estimates of unionization's true effect. In short, despite its intuitive appeal, a fixed-effects modeling approach is ill-suited to the peculiarities of the mining industry during this period.[22]

Importantly, most of the statistical biases identified in prior literature will tend, if anything, to attenuate unionization's measured effect. For example, virtually all scholars that consider the possibility of selection bias have argued, on both theoretical and empirical grounds, that inherently hazardous mines are *more* likely to unionize (Brown 1995; Leigh 1982; Worrall and Butler 1983; Hirsch and Berger 1984; Hills 1985; Robinson 1988b; Robinson 1991). If this is correct, then because I cannot control for each mine's intrinsic perilousness, any estimates of unions' beneficial impact will likely be biased *downward*.[23]

Another type of bias that has received much attention in the literature, often referred to as "reporting bias," stems from the fact that injury reporting practices may differ across union and nonunion environments. For example, nonunion miners may fail to report legitimate injuries due to a fear of reprisal from their employers. At the same time, some unions may facilitate or even

[21] Industry stakeholders recounted that, in recent decades, mines that underwent changes in union status typically did so in the wake of adverse economic shocks, such as sudden changes in the regulatory environment. The data seem to bear out this claim. At least 19% of coal mines that de-unionized and 76% of mines that became unionized during the sample period experienced major disruptions (defined as production, employment, or hours worked dropping by over 50%; a year or more of inactivity; and/or a change of the mine operator or mine controller) during the year when the transition took place. Such operational discontinuities are likely to have exerted an independent effect on mine safety, making it difficult to empirically isolate the impact of unionization. Moreover, the unusually precarious environment in which unions were forced to operate before or after these transitions may have limited their capacity to influence workplace behavior.
[22] Notwithstanding these significant methodological concerns, for the benefit of the interested reader, Appendix Table A3 presents results from mine-level fixed-effects models.
[23] One might imagine, alternatively, a form of adverse selection in which the *most* dangerous mines are the *least* likely to unionize. For example, mine operators that invest the least in workplace safety may invest the most in (or become especially skilled at) defeating union certification elections. Although this form of adverse selection seems plausible – especially in monopsonistic or oligopsonistic labor markets – I am unaware of any prior literature that confirms its existence.

encourage the reporting of fraudulent or exaggerated claims (Hirsch, MacPherson, and Dumond 1997; Morse et al. 2003). Even in the absence of outright employer intimidation or employee fraud, institutional norms may differ regarding what "counts" as a compensable occupational injury. For example, Azaroff, Levenstein, and Wegman (2002) suggest that attitudinal barriers that impede the detection and reporting of injuries are weaker in unionized workplaces, especially for injuries that are relatively minor and/or hard to diagnose. In apparent support of this hypothesis, Hirsch, MacPherson, and Dumond (1997) and Morse et al. (2003) find that even among those who self-report similar rates of occupational injuries, union workers are more likely to receive workers' compensation benefits. In short, reporting bias may also diminish the measured impact of unionization.

Fortunately, my data enable me to explore the magnitude of reporting bias indirectly by examining four different injury categories that vary in their relative susceptibility to such bias: non-traumatic injuries, total injuries, traumatic injuries, and fatalities. As illustrated in Figure 4, non-traumatic injuries are hypothesized to be the most prone to reporting bias because they (by definition) include cumulative injuries whose work-relatedness is often difficult to confirm. At the opposite end of the continuum are workplace fatalities, which are virtually impossible to hide from authorities and regulators. The remaining two measures – total and traumatic injuries – fall in between these two extremes. Total injuries are less prone to reporting bias than non-traumatic injuries because they include fatalities and severe traumatic injuries. Traumatic injuries are hypothesized to be even less susceptible to reporting bias than total injuries since they exclude cumulative injuries.

If there is significant reporting bias across union and nonunion mines, the union safety effect (if any) should appear strongest in the fatality rate models; weaker in the traumatic injury rate models; weaker still in the total injury rate models; and weakest of all in the non-traumatic injury rate models. In other words, union status should predict more and more injuries as the focus of inquiry shifts from fatalities, to traumatic injuries, to total injuries, and finally to non-traumatic injuries. The following section summarizes my main findings, but space constraints preclude me from presenting detailed results from each and every model specification and robustness check that was performed. For the benefit of the interested reader, the *Companion Website*[24] presents a variety of extra specifications and robustness checks.

[24] See http://amorantz.stanford.edu/papers/union-coal-mine-safety/

Results

Tables 2-4 present the study's main findings for the four different outcomes examined: non-traumatic injuries, total injuries, traumatic injuries, and fatalities. For ease of interpretation, I transform each coefficient into an incident rate ratio (IRR), whereby a coefficient of 1 indicates no change at all in predicted injuries; coefficients between 0 and 1 represent a predicted fall in injuries (e.g. a coefficient of 0.97 represents an approximate 3% decline); and coefficients greater than one represent predicted increases (e.g. a coefficient of 1.03 represents an approximate 3% rise).

Results from the leading models presented in Table 2, which capture the average or "net" effect of unionization across all mines and time periods, display a striking pattern. On one hand, unionization is associated with a very sizable (more than 25%), robust, and statistically significant *increase* in non-traumatic injuries across all specifications. The results for total injuries are similar but more muted: the disparity is smaller in magnitude, when significant, and is not robust across all specifications. Traumatic injuries, on the other hand, present a very different picture; unionization is now associated with a sizable (more than 20%) and highly significant *decline* in traumatic injuries across all specifications. Similarly, unionization is associated with an even larger (more than 50%) fall in fatal injuries across all six specifications.

In short, the model results are broadly consistent with both of the hypotheses initially posed. First and foremost, unionization is associated with a significant decline in those mine accidents that are least vulnerable to reporting bias. Secondly, the dramatic extent to which unions' measured effect varies by injury type suggests that there are indeed significant discrepancies in reporting practices across union and nonunion mines.[25]

Table 3 probes whether the trends observed vary by mine size. Although the analysis is restricted to the baseline specification, the continuous mine-size term is replaced by discrete size quartile dummies (defined such that a fourth of all mine-quarters fall into each quartile), and the "union" and "union X size" terms are replaced with "union X size quartile" interaction terms. At first glance, the results presented in Table 3 are surprising. Most prior scholarship suggests that larger firms – regardless of union status – have the strongest intrinsic incentives to invest in

[25] The fact that as noted in Table 1, traumatic injuries comprise a much smaller percentage of total injuries in union mines (30.1%) than in nonunion mines (41.9%) might also be construed as "circumstantial evidence" of reporting bias.

workplace safety (Weil 1987:124-28, Genn 1993:220-230, Fenn and Veljanovski 1988:1065; Reilly, Paci, and Holl 1995:280; Ruser 1985:485; Frick and Walters 1998:368). Therefore, one might expect unions' impact on workplace safety to be the strongest among smaller mines. Yet Table 3 reveals precisely the opposite trend: unionization's depressive effect on traumatic and fatal injuries is the greatest and most robust among larger mines. What might explain this seemingly counterintuitive result? Perhaps unions are better equipped to influence workplace safety and injury reporting policies in mines that exceed a certain size threshold. For example, unions in small mines may find it difficult to establish active health and safety committees, conduct independent inspections, and consistently accompany MSHA inspectors on their tours.

Finally, Table 4 probes changes over time by subdividing the analysis into three discrete time periods (1993-1998, 1999-2004, and 2005-2010) using the baseline specification.[26] For both non-traumatic and total injuries, the disparity between union and nonunion mines diminishes over time. Traumatic injuries, however, display a different trend: although there is only a small disparity across groups in the mid 1990s, unionization is associated with a significant and sizable (more than 30%) *decline* in traumatic injuries in subsequent years. Fatal injuries reveal a mixed pattern: although unionization is associated with a large (albeit only at a 10% level of significance) decrease in fatalities around the turn of the century, the disparity shrinks and loses statistical significance in later years. At least if one confines scrutiny to traumatic injuries, then, the data suggest that the union safety effect could be a relatively recent phenomenon.

Although not the focus of this study, the other covariates included as right-hand-side variables reveal several interesting patterns. Appendix Table A2 displays expanded regression coefficients for all of the baseline models. Although many of the estimated effects mirror those of prior studies, some either conflict with previous estimates or illuminate relationships that prior scholarship has not explored. The *Companion Website* discusses these and other ancillary findings.

Interpretation

Taken at face value, my results are broadly consistent with three hypotheses regarding the

[26] The data are broken into three time periods for clarity of presentation. Models with alternative time groupings, presented on the *Companion Website*, do not materially change the results for non-traumatic, total or traumatic injuries. The findings for fatal injuries, although differing somewhat from those presented here, are similarly equivocal.

relationship between unionization and coal mine safety. First, unionization may have improved "real" mine safety levels (reflected in traumatic and fatal injury rates) several decades after the passage of the Coal Act. Second, reporting bias has probably confounded prior studies of unionization's impact, especially when minor and non-traumatic injuries are included in injury counts. Finally, in the latter half of the twentieth century, the union safety effect may not have existed until the turn of the millenium.

Several important questions remain. First, what is the likelihood that omitted variable bias has confounded my identification strategy?

One potentially consequential mine-level characteristic that I cannot observe is the age distribution of the workforce. Epidemiological literature on the frequency of accidents by age is thin and conflicting. Some studies suggest that younger and less experienced miners sustain more injuries on the job (e.g. Laflamme and Blank 1996), but the scholarship is not unanimous on this point. (See, for example, Souza 2009.) Based on a careful review of existing literature, Salminen (2004) reports a bifurcated pattern, in which young workers are more susceptible to non-fatal injuries and older workers are more prone to occupational fatalities. If the distribution of age or experience differs substantially across union and nonunion mines – and if such age differentials independently affect miners' likelihood of sustaining traumatic or fatal injuries – this could bias my results. Unfortunately, demographic variables are unavailable at the mine level, making it difficult to verify the existence, let alone to estimate the magnitude, of such biases.[27] The only source that facilitates any age comparisons is the Current Population Survey (CPS), which includes questions regarding age, occupation, and union membership. Although the small sample size allows for only rough comparisons, the data suggest that the average miner is older today than he was in 1990; that union miners are older than non-union miners; and that the latter discrepancy has grown in recent decades.[28] Yet this age differential seems unlikely to explain

[27] The decennial survey administered by the U.S. Census Bureau – even the "long" form administered to 5% of the population for the Public-Use Microdata Samples (PUMS) – contains no information on union membership. The U.S. Census Bureau's Longitudinal Employer-Household Dynamics Program (LEHD) does contain mine-level demographic data. However, the LEHD dataset excludes Kentucky and Pennsylvania, which contain 43% of all underground, bituminous mines in the U.S., and data for West Virginia and Virginia – which contain an additional 46% of mines in our sample – are available only for 1997 onwards. Additionally, since the Census Bureau and MSHA use different employer identifiers, merging these two datasets would pose significant challenges. (Interview with Angela Andrus, Census Research Data Center, February 9, 2011; Interview with Emily Isenberg at the LEHD Program, U.S. Census, March 3, 2011.)

[28] For example, the typical (median) unionized miner was 41 in 1990; 46 in 2000; and 51 in 2010. In contrast, the median nonunion miner was 38 in 1990, 45 in 2000, and 45.5 in 2010. A t-test comparing the mean ages of union

much of the union safety effect, for two reasons. First, although the union–nonunion gap in the frequency of traumatic injuries expanded markedly during the 1990s, the gap in the proportions of young miners grew, if at all, only marginally during this period.[29] Secondly, although the negative correlation between unionization and mining fatalities intensified during the late 1990s, the union–nonunion gap in the prevalence of older miners, if anything, slightly widened.[30]

Several stakeholders suggested that unionized miners are also more experienced than their nonunionized counterparts (although CPS data reveal no differences in median educational attainment[31]), and that total compensation including fringe benefits is higher at union mines, although both disparities have diminished in recent decades. Unfortunately, there are no data available with which to test the validity of either claim.[32]

In short, I cannot rule out the possibility that omitted variables have biased my analysis.[33] Nevertheless, the scant information available on disparities in miner demographics do not correlate particularly well with the trends observed in the data, suggesting that this particular source of bias, at least, may not be a major concern.

If the observed relationship between unionization and mine safety is indeed causal, this raises a second important question: why do my estimates differ so sharply from prior literature? Perhaps the union safety effect has always existed, but has eluded detection because of the

and nonunion miners reveals that union miners are older at a 10% level of significance. I use CPS Outgoing Rotation Group (ORG) survey data to derive these statistics, restricting the CPS data to observations within the coal mining industry, in the labor force, and not self-employed. Historical CPS data, including the ORG data, is available at http://www.nber.org/cps/.

[29] In 1990 the CPS data indicates that 5% of union miners and 16% of nonunion miners were under the age of 30. In 2000, the percentage of union miners below 30 was 0%, versus 12% of nonunion miners.

[30] In 1990 the CPS data indicates that 16% of union miners and 10% of nonunion miners were over the age of 50. By 2000, 29% of union miners and 21% of nonunion miners were over the age of 50.

[31] The CPS data indicate that the median education level of both union and nonunion miners was a high school diploma or GED in 1990, 2000, and 2010, respectively.

[32] The CPS does not ask any questions regarding the prevalence or magnitude of "fringe" benefits such as pensions or life insurance. Questions regarding job tenure are collected every other year as part of the January supplement, which typically includes about fifteen respondents from the mining industry, of whom only a handful belong to a union. Due to these extremely small sample sizes, one cannot draw any meaningful inferences regarding whether (and to what extent) the average tenure of union and nonunion miners has varied in recent years.

[33] If profitable mines are more (or less) likely to become unionized, profitability could also be an important source of omitted variable bias. Unfortunately, I cannot construct a credible proxy for mine profitability. On the revenue side of the equation, for example, the data provided by the EIA only include revenue from domestic sources, whereas sale of (typically metallurgical) coal abroad can be a critical and highly volatile source of revenue (see, for example, Radenmacher and Braun, 2011). Meanwhile, on the cost side, many factors that affect production – such as capital investments, labor costs per hour, use of subcontracting, receipt of federal subsidies, etc. – cannot be observed in the data; the only relevant information available is total hours worked. In an effort to at least partially mitigate this potential source of bias, I include a productivity measure (thousands of tons produced annually per full-time equivalent worker) in all specifications.

methodological shortcomings of and limited data used in prior work. Since complete data from the 1970s no longer exist, I cannot replicate these early studies. However, when I analyze my own data using a methodology similar to that of Appleton and Baker (1984), the results are qualitatively not unlike those reported here, casting doubt on the possibility that findings reported in early empirical scholarship were entirely spurious.[34] Alternatively, it could be that unions did not, in fact, reduce mining hazards until decades after the Mine Act's passage. Although far from conclusive, the replication exercise suggests that the union safety effect may indeed be a relatively recent phenomenon.

If the latter conclusion is correct – and unions had little impact on mine safety until just before the turn of the millinium – the question is why. There are several possibilities. First, fluctuations over time in the stringency of MSHA's enforcement scrutiny may affect union and nonunion mines differently. For example, Weil (1987), examining data from the early 1980s, finds that union mines were subject to more stringent enforcement scrutiny.[35] Examining data from 1995-2009, Morantz (2012) finds that this disparity has persisted along several dimensions.[36] If MSHA inspects union mines more intensively than nonunion mines – and if this differential has widened over time – it could help explain the observed trends. However, detailed comparison of the results presented here with those reported in Morantz (2012) casts doubt on this hypothesis. Whereas the "union safety effect" described in the Results section is strongest among large mines, the enforcement disparities reported in Morantz (2012) diminish sharply with mine size.

Secondly, unions may have shifted their institutional priorities in the 1990s, deliberately choosing to forfeit potential wage increases in exchange for enhanced workplace safety. CPS data do show some convergence in median (real) wages of union and nonunion miners since the early 2000s. However, there are several reasons to doubt that the UMWA's leadership has

[34] See the *Companion Website* for a detailed description of my attempt to replicate Appleton and Baker's methodology using my own dataset.
[35] Weil (1987) finds that union mines are more likely to designate employee representatives; receive more frequent MSHA inspections of longer average duration; are granted shorter periods in which to abate violations; are granted fewer abatement extensions; receive more citations per inspection; pay higher penalties per violation; and are less successful in reducing penalty amounts through MSHA's internal administrative appeals process than nonunion mines (pp. 120-185).
[36] Morantz (2012) finds that unionization is associated with increases in regular inspection hours per mine quarter, total inspection hours per regular inspection, the proportion of total inspection hours spent onsite, and the proposed fine assessed for significant and substantial violations.

pursued such a strategy.[37]

Finally and most importantly, it may have taken time for the UMWA's leadership to train a cadre of union members capable of effectively exercising their contractual and newfound statutory rights. In the words of one union official, "It can take a generation to institutionalize a robust safety culture and build a corps of experienced miners who can train the newcomers."[38] The labor strife that characterized much of the 1970s (and to a lesser extent the 1980s) likely impeded unions' capacity to enact meaningful changes. Weil (1994:199-200) has identified the election of Rich Trumka in 1982 to the presidency of the UMWA as a critical turning point, after which the union prioritized and funded the training of health and safety committee members. By the late 1980s and early 1990s, under the leadership of Joseph Main, the UMWA's Department of Health and Safety took more systematic measures to train its rank and file, such as the institution of local union training programs.[39] In short, changes in the leadership and institutional focus of the UMWA during the 1970s and '80s that were intended to increase the union's long-term impact on mine safety may not have borne fruit until the 1990s.

Conclusion

Although the United Mine Workers of America has always been a vigorous advocate for miners' safety, prior empirical literature has failed to detect any evidence of a union safety effect on injury or fatality rates. If anything, prior scholarship has reported a puzzling negative relationship between unionization and mine safety during the 1970s, the decade immediately following the Coal Act's passage. This study uses more comprehensive data and updated statistical methods to re-examine the relationship between unionization and mine safety. I focus

[37] First, according to the UMWA leadership, the disparity in benefits between union and nonunion miners has progressively widened even as the gap in hourly wages has narrowed. Therefore, they claimed, the true overall disparity in union–nonunion compensation has changed little in recent years. To the best of my knowledge, this assertion cannot be tested with available data. (Telephone conferences with Brian Sanson, May 21, 2010; and Phil Smith, May 28, 2010.) Second, the UMWA's leadership explained that young miners that began entering the workforce in large numbers in the first decade of the 21st century are much less likely to have family members who are miners, or to have grown up in "mining towns" where explosions and collapses are part of the collective memory. As a result, they show relatively little interest in safety issues. As one official put it, "it has become very difficult to organize on safety issues." (Telephone conference with Phil Smith, May 28, 2010.) Finally, CPS data show no significant convergence in *mean* real wages of union and nonunion miners. The recent convergence in *median* wages could be driven, therefore, by a growing similarity in the prevalence of inexperienced miners rather than enhanced congruence of pay scales. Unfortunately, the extreme paucity of miners surveyed for the CPS sample makes it difficult to conclusively resolve the issue.

[38] Telephone interview with Phil Smith, UMWA, May 28, 2010.

[39] Weil (1987:200); Telephone interview with Michael Buckner, UMWA's Director of Research from 1981-2005, on March 3, 2011.

on the 1993-2010 period, for which reliable mine-level information on union status is available, and use a variety of techniques to mitigate potential biases.

I find that unionization is associated with a sizable and robust decline in both traumatic injuries and fatalities, the two safety outcomes that I argue are the least prone to reporting bias. I construe these results as evidence for a "real" union safety effect in U.S. underground coal mining. At the same time, I find that unionization is associated with higher total and non-traumatic injuries, lending credence to claims that injury reporting practices differ significantly across union and nonunion mines.

Interestingly, the union safety effect on traumatic injuries seems to have escalated just before the turn of the millenium. I propose several possible explanations for this trend, including an overall improvement in labor relations since the 1970s, fluctuations over time in the stringency of MSHA's enforcement scrutiny, the growing competitive pressures faced by union leaders, and the increasing sophistication and professionalization of UMWA safety programs. The empirical evidence available, although scant, suggests that the latter hypothesis is the most promising. Exploring the historical relationship between UMWA activities and mine safety in greater detail – including a richer, updated institutional account of the precise mechanisms whereby organized labor affects safety outcomes – would be a promising topic for future inquiry.

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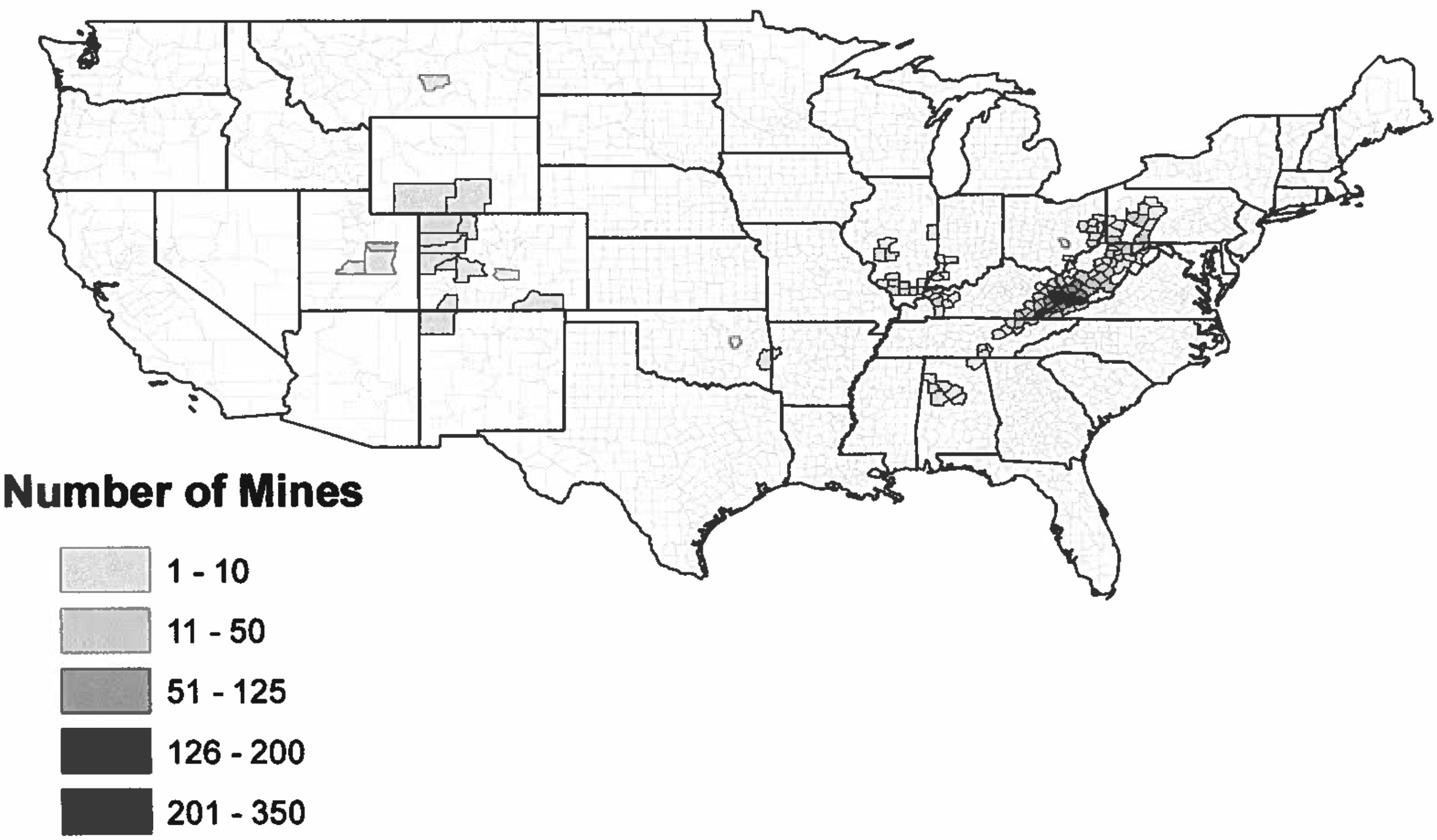
Figure 1. Underground Bituminous Coal Mines by County



County information was provided by MSHA. The county-level mine counts incorporate all 2,662 underground bituminous coal mines that were active for at least one quarter between 1993 and 2010. Note that, due to high rates of entry and exit in the industry, no more than half of the sample was active in any given quarter.

Figure 2. Union Penetration

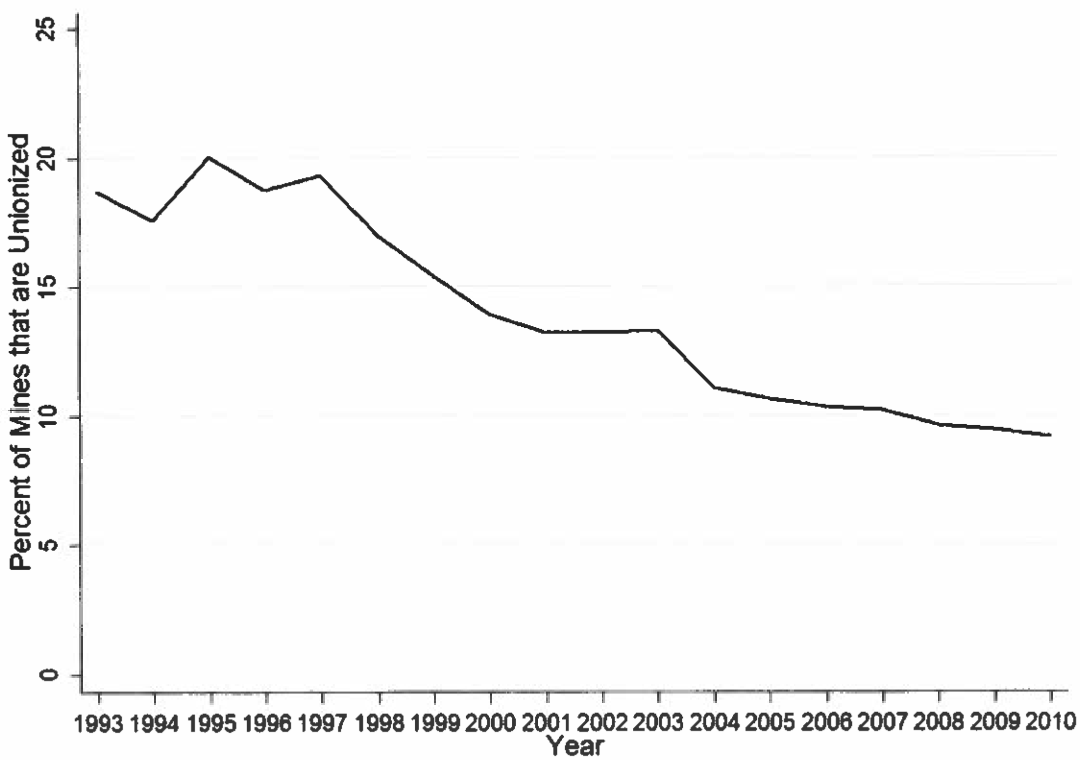


Figure 3. Rates of Total and Traumatic Injuries

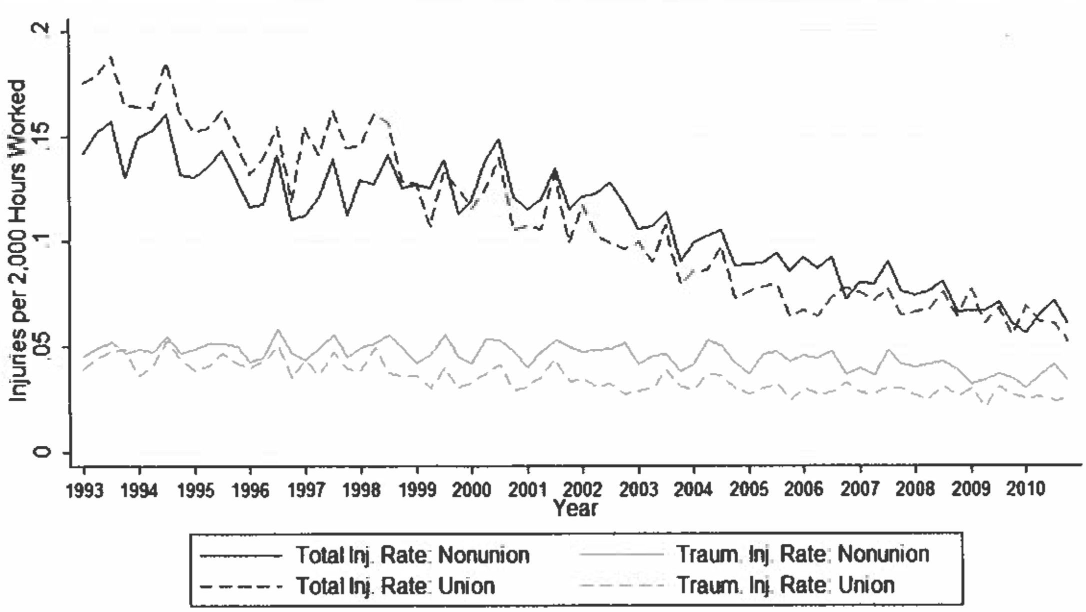


Figure 4. Susceptibility of Injury Type to Reporting Bias

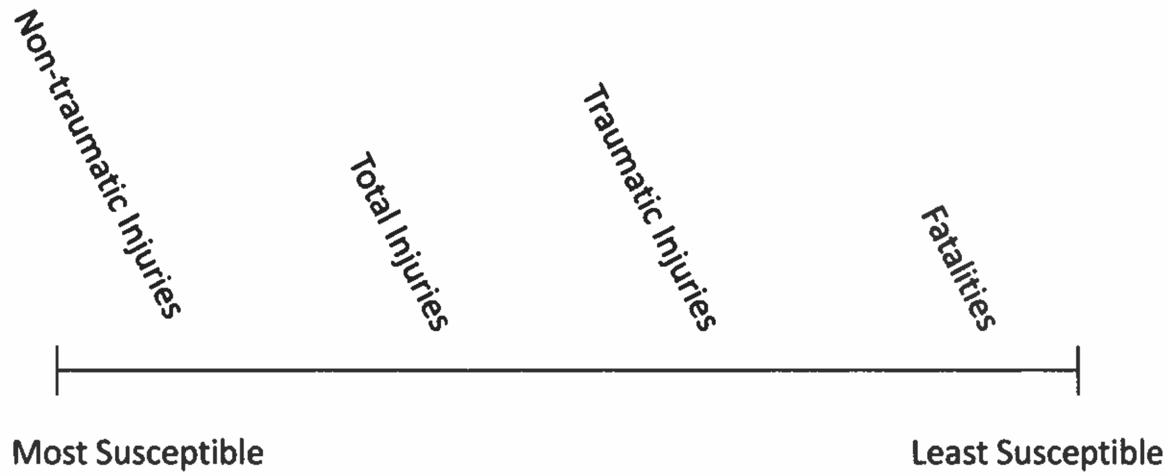


Table 1: Injury Type Breakdown

	All Mines:		Union Mines:		Nonunion Mines:	
Injury Type	**Frequency**	**% of Total**	**Frequency**	**% of Total**	**Frequency**	**% of Total**
Non-Traumatic[a]	47,793	62.5%	20,153	69.9%	27,640	58.1%
Total	76,440	100%	28,847	100%	47,593	100%
Traumatic[b]	28,647	37.5%	8,694	30.1%	19,953	41.9%
Fatality	341	0.4%	75	0.3%	266	0.6%

Notes:

This table reports the frequency of each injury type, as well as the share of total injuries that each category represents. Note that these categories are not mutually exclusive.

[a] The non-traumatic injury category is comprised of all injuries not classified as traumatic (see below). Note that the non-traumatic and traumatic injury counts sum to the total injury count.

[b] The traumatic injury category is comprised of the following: amputations; enucleations; fractures; chips; dislocations; foreign bodies in eyes; cuts and lacerations; punctures; burns/scalds; crushings; chemical, electrical, and laser burns; and fatalities. See footnote 13 for more details on this injury category.

Table 2: Effect of Union Status on Injury Frequency: Baseline Models

Specification:	**Baseline (Hours Worked)**		**Employees**		**Tonnage**	
Mine/Controller Size Units:	100 Quarterly FTEs		100 Employees		Millions of Tons	
Version:	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version
Non-Traumatic Injury Model	1.359***	1.269***	1.381***	1.299***	1.367***	1.290***
	(0.07)	(0.10)	(0.07)	(0.10)	(0.07)	(0.09)
Total Injury Model	1.157***	1.056	1.170***	1.072	1.144***	1.045
	(0.05)	(0.07)	(0.05)	(0.07)	(0.05)	(0.06)
Traumatic Injury Model	0.774***	0.696***	0.774***	0.695***	0.764***	0.683***
	(0.04)	(0.05)	(0.04)	(0.05)	(0.04)	(0.04)
# of Observations	38,890	24,593	38,890	24,593	38,890	24,593
# of Union Mines / # of Total Mines	355 / 2,635	186 / 1,684	355 / 2,635	186 / 1,684	355 / 2,635	186 / 1,684
Fatality Model	0.346***	0.421*	0.358***	0.437*	0.369***	0.424**
	(0.13)	(0.19)	(0.13)	(0.20)	(0.13)	(0.18)
# of Observations	11,045	6,948	11,045	6,948	11,045	6,948
# of Union Mines / # of Total Mines	352 / 2,568	182 / 1,644	352 / 2,568	182 / 1,644	352 / 2,568	182 / 1,644

*Significance levels: *** 1%, ** 5%, * 10%. Standard errors, clustered at the mine level, are shown in parentheses.*
Results Presented: The table reports IRR (incidence rate ratio)[a] coefficients on the union indicator variables in negative binomial regression models. Hours worked is the exposure term.
Definitions: A quarterly FTE is defined as 500 hours worked.
Unit of Observation: The unit of observation is the mine-quarter for the non-traumatic, total, and traumatic injuries regressions. The unit of observation is the mine-year for fatality regressions.
Dependent Variables: The dependent variables are counts of injuries of each type (specified in the far-left column) that occur underground. *Traumatic injuries* are defined to include the following: amputations; enucleations; fractures; chips; dislocations; foreign bodies in eyes; cuts and lacerations; punctures; burns/scalds; crushings; chemical, electrical, and laser burns; and fatalities. (See footnote 13 for more details on the definition on traumatic injuries.) The sum of traumatic and non-traumatic injuries comprises *total injuries*.
Independent Variables: All models include the following regressors: union dummy, mine size (a continuous variable whose units are specified in column header), union X mine size, logged controller size (a continuous variable whose units are specified in column header), mine age, mine productivity, total lost-work injuries (in hundreds) during previous calendar year (for fatality models) or previous four quarters (for non-fatality models), total penalty points (in thousands) during previous calendar year (for fatality models) or previous four quarters (for non-fatality models), dummies indicating presence of each respective mine subunit, quarter/year dummies, district dummies, and a constant term. Public-fields versions also include a longwall indicator. Confidential-fields versions also include the number of coal beds, mean coal bed thickness (in yards), subsidiary indicator, captive production

as a percentage of total production, recoverable coal reserves, and mining method percentages. See Appendix C for complete variable definitions. An expanded version of this table, including a full covariate report, is available at http://amorantz.stanford.edu/papers/union-coal-mine-safety/.
Sample: The sample consists of underground bituminous coal mines with positive coal production and positive hours worked. The public-fields versions contain mine-quarters from 1993–2010, whereas the confidential-fields versions are restricted to 1998–2010. Because the historical variables (lost-work injuries and penalty points) are summed up over the previous four *quarters* in the non-traumatic, total, and traumatic injuries regressions but are summed up over the previous *calendar year* in the fatality regressions, some mines excluded from the fatality models are included in the other models. For example, if a mine is open for all of only one calendar year, it will have no historical data at the *yearly* level, but it will have historical data for three of the four *quarters* it was open. The number of union mines is computed by counting the mines that were unionized for any of the mine-quarters in the sample period. The number of total mines is computed by counting each mine in the sample, regardless of union status.
[a] A coefficient of 1 indicates no change at all in predicted injuries; coefficients between 0 and 1 represent a predicted fall in injuries (e.g. a coefficient of 0.97 represents a 3% decline); and coefficients greater than one represent predicted increases (e.g. a coefficient of 1.03 represents a 3% rise).

Table 3: Effect of Union Status on Injury Frequency: Discrete Size Groups

	Non-Traumatic Injuries	Total Injuries	Traumatic Injuries	Fatalities
Union X Size Quartile 1	1.222	1.227*	1.223	0.000***
	(0.16)	(0.14)	(0.19)	(0.00)
Union X Size Quartile 2	1.237***	1.171**	0.988	0.321
	(0.10)	(0.08)	(0.09)	(0.32)
Union X Size Quartile 3	1.424***	1.196***	0.815***	0.824
	(0.12)	(0.08)	(0.05)	(0.51)
Union X Size Quartile 4	1.250***	0.999	0.695***	0.307***
	(0.07)	(0.05)	(0.04)	(0.09)
Observations	38,890	38,890	38,890	11,045
# of Union Mines / # of Total Mines	355 / 2,635	355 / 2,635	355 / 2,635	352 / 2,568

*Significance levels: *** 1%, ** 5%, * 10%. Standard errors, clustered at the mine level, are shown in parentheses.*
Results Presented: The table reports IRR (incidence rate ratio)[a] coefficients on the union indicator variables in negative binomial regression models. Hours worked is the exposure term.
Definitions: A quarterly FTE is defined as 500 hours worked.
Unit of Observation: The unit of observation is the mine-quarter for the non-traumatic, total, and traumatic injuries regressions. The unit of observation is the mine-year for fatality regressions.
Dependent Variables: The dependent variables are counts of injuries of each type (specified in the top row) that occur underground. *Traumatic injuries* are defined to include the following: amputations; enucleations; fractures; chips; dislocations; foreign bodies in eyes; cuts and lacerations; punctures; burns/scalds; crushings; chemical, electrical, and laser burns; and fatalities. (See footnote 13 for more details on the definition on traumatic injuries.) The sum of traumatic and non-traumatic injuries comprises *total injuries*.
Independent Variables: All specifications presented above rely exclusively on regressors that are publicly available. In addition to discrete union-size interaction terms, all models include the following regressors: size quartiles (as determined by total FTEs), logged controller size (a continuous variable reflecting the controller's total number of FTEs), mine age, mine productivity, total lost-work injuries (in hundreds) during previous calendar year (for the fatality model) or previous four quarters (for non-fatality models), total penalty points (in thousands) during previous calendar year (for the fatality model) or previous four quarters (for non-fatality models), dummies indicating presence of each respective mine subunit, quarter/year dummies, district dummies, longwall indictor, and a constant term. See Appendix C for complete variable definitions. An expanded version of this table, including a full covariate report, is available at http://amorantz.stanford.edu/papers/union-coal-mine-safety/.
Sample: The sample consists of underground bituminous coal mines with positive coal production and positive hours worked from 1993–2010. Because the historical variables (lost-work injuries and penalty points) are summed up over the previous four *quarters* in the non-traumatic, total, and traumatic injuries regressions but are summed up over the previous *calendar year* in the fatality regressions, some mines excluded from the fatality models are included in the other models. For example, if a mine is open for all of only one calendar year, it will have no historical data at the *yearly* level, but it will have historical data for three of the four *quarters* it was open. The number of union mines is computed by counting the mines that were unionized for any of the mine-quarters in the sample period. The total number of mines is computed by counting each mine in the sample, regardless of union status.
[a] A coefficient of 1 indicates no change at all in predicted injuries; coefficients between 0 and 1 represent a predicted fall in injuries (e.g. a coefficient of 0.97 represents a 3% decline); and coefficients greater than one represent predicted increases (e.g. a coefficient of 1.03 represents a 3% rise).

Table 4: Effect of Union Status on Injury Frequency: Time Trend

Model	FTE Public (Baseline)	1993-1998	1999-2004	2005-2010
Non-Traumatic Injury Model	1.359*** (0.07)	1.504*** (0.09)	1.243** (0.12)	1.283** (0.16)
Total Injury Model	1.157*** (0.05)	1.320*** (0.07)	1.052 (0.09)	1.003 (0.10)
Traumatic Injury Model	0.774*** (0.04)	0.919 (0.06)	0.673*** (0.06)	0.698*** (0.08)
Observations	38,890	16,629	11,460	10,801
# of Union Mines / # of Total Mines	355 / 2,635	294 / 1,765	129 / 1,141	65 / 928
Fatality Model	0.346*** (0.13)	0.378* (0.19)	0.331* (0.20)	0.555 (0.38)
Observations	11,045	4,763	3,308	2,974
# of Union Mines / # of Total Mines	352 / 2,568	290 / 1,690	128 / 1,093	65 / 903

*Significance levels: *** 1%, ** 5%, * 10%. Standard errors, clustered at the mine level, are shown in parentheses.*
Results Presented: The table reports IRR (incidence rate ratio)[a] coefficients on the union indicator variables in negative binomial regression models. Hours worked is the exposure term. The "FTE Public (Baseline)" column contains coefficient estimates from the principal baseline models (using 100 quarterly FTEs as the size measure and relying exclusively on public data) presented in Table 2. The results presented in the other three columns correspond, respectively, to coefficient estimates from identical models run on six-year subsamples.
Definitions: A quarterly FTE is defined as 500 hours worked.
Unit of Observation: The unit of observation is the mine-quarter for the non-traumatic, total, and traumatic injuries regressions. The unit of observation is the mine-year for fatality regressions.
Dependent Variables: The dependent variables are counts of injuries of each type (specified in the far-left column) that occur underground. *Traumatic injuries* are defined to include the following: amputations; enucleations; fractures; chips; dislocations; foreign bodies in eyes; cuts and lacerations; punctures; burns/scalds; crushings; chemical, electrical, and laser burns; and fatalities. (See footnote 13 for more details on the definition on traumatic injuries.) The sum of traumatic and non-traumatic injuries comprises *total injuries*.
Independent Variables: All specifications presented above rely exclusively on regressors that are publicly available. All models include the following regressors: union dummy, mine size (a continuous variable reflecting the mine's total number of FTEs) , union X mine size, logged controller size (a continuous variable reflecting the controller's total number of FTEs), mine age, mine productivity, total lost-work injuries (in hundreds) during previous calendar year (for fatality models) or previous four quarters (for non-fatality models), total penalty points (in thousands) during previous calendar year (for fatality models) or previous four quarters (for non-fatality models), dummies indicating presence of each respective mine subunit, quarter/year dummies, district dummies, a longwall indicator, and a constant term. See Appendix C for complete variable definitions. An expanded version of this table, including a full covariate report, is available at http://amorantz.stanford.edu/papers/union-coal-mine-safety/.
Sample: The sample consists of underground bituminous coal mines with positive coal production and positive hours worked from 1993–2010. Because the historical variables (lost-work injuries and penalty points) are summed up over the previous four *quarters* in the non-traumatic, total, and traumatic injuries regressions but are summed up over the previous *calendar year* in the fatality regressions, some mines excluded from the fatality models are included in the other models. For example, if a mine is open for all of only one calendar year, it will have no

historical data at the *yearly* level, but it will have historical data for three of the four *quarters* it was open. The number of union mines is computed by counting the mines that were unionized for any of the mine-quarters in the sample period. The total number of mines is computed by counting each mine in the sample, regardless of union status.

[a] A coefficient of 1 indicates no change at all in predicted injuries; coefficients between 0 and 1 represent a predicted fall in injuries (e.g. a coefficient of 0.97 represents a 3% decline); and coefficients greater than one represent predicted increases (e.g. a coefficient of 1.03 represents a 3% rise).

Appendix Table A1: Characteristics of Underground, Bituminous Coal Mines: Sample Means

Variable	*Union Mean*	*Nonunion Mean*	Variable	*Union Mean*	*Nonunion Mean*
Total sample size[a]			**Mine characteristics**		
Mine-quarters	5,689	33,201	Mine age (in years)	17.15	6.89
Mines[b]	355	2,444		(16.44)	(7.72)
Injury Rates (per			Productivity	7.41	6.93
annual FTE)				(4.05)	(4.59)
Total injuries	0.1295	0.1076			
	(0.1714)	(0.2676)	Percent Captive	0.0798	0.0738
Traumatic injuries	0.0357	0.0397	Production	(0.2582)	(0.2563)
	(0.0357)	(0.0397)			
Non-traumatic injuries	0.0937	0.0679	Subsidiary indicator	0.3529	0.2062
	(0.1413)	(0.1743)		(0.4779)	(0.4046)
Fatalities	0.0003	0.0010			
	(0.0062)	(0.0537)	Longwall indicator	0.3146	0.0408
				(0.4644)	(0.1978)
Mine and Controller					
Size Measures			Subunits contained[c]		
Mine FTEs	194.68	58.76	*Surface*	0.8613	0.8272
	(207.44)	(87.40)		(0.3457)	(0.3781)
Size Quartile 1	9.77	9.87	*Mill or prep plant*	0.2781	0.0439
	(4.12)	(4.44)		(0.4481)	(0.2048)
Size Quartile 2	26.36	25.39			
	(5.28)	(5.32)	Mining method		
Size Quartile 3	51.53	49.33	percentages		
	(10.57)	(10.12)	*Conventional*	0.0755	0.1625
Size Quartile 4	320.67	179.18		(0.2641)	(0.3675)
	(200.23)	(135.64)	*Continuous*	0.6552	0.7763
				(0.4262)	(0.4088)
Mine Employees	176.65	51.91	*Longwall*	0.664	0.0341
	(181.42)	(73.47)		(0.3895)	(0.1644)
			Shortwall	0.0019	0.0001
Mine Tonnage	368,828	123,184		(0.0379)	(0.0110)
	(459,803)	(267,355)			
			Geological features		
Controller FTEs	1,451.81	632.69	Number of Coal beds	1.0197	0.9999
	(1,910.59)	(1,146.56)		(0.1537)	(0.1811)
Controller employees	1,292.98	542.75	Mean coal bed	0.9227	0.8483
	(1,673.56)	(980.04)	thickness (in yards)	(0.8580)	(0.713)
Controller tonnage	3,125,170	1,296,810	Recoverable reserves	19,593	6,857
	(4,624,872)	(2,556,860)	(in millions of tons)	(31,958)	(27,711)

Results Presented: Table contains mean values for all mine quarters in each group; standard deviations are in parentheses. See Appendix C for complete variable definitions.

[a] Total sample sizes represent counts (of mine-quarters and of mines, respectively) as opposed to mean values.

[b] Because a mine that was unionized for part of the sample period and nonunionized for part of the sample period is counted here as both a union mine and a nonunion mine, some mines are double counted for a total of 2,799

mines. The total number of mines used in the baseline regressions is 2,635. The difference between these two numbers, 164 mines, is the number of mines that switched union status at some point during the sample period. These are the mines that are included in the fixed effects models in Appendix Table A3.

[c] Only descriptive statistics for the surface and the mill or prep plant subunits are shown here. Other subunits include auger subunit; culm-refuse subunit; dredge subunit; independent shops or yard subunit; strip, quarry, or pit subunit; underground subunit; and other subunits. Descriptive statistics for all ten subunits are available on the *Companion Website* (http://amorantz.stanford.edu/papers/union-coal-mine-safety/).

Appendix Table A2: Effect of Union Status on Injury Frequency: Expanded Covariate Report for Baseline, Public-Fields Specifications

	Non-Traumatic Injury Model	Total Injury Model	Traumatic Injury Model	Fatality Model
Union	1.335***	1.143***	0.780***	0.346***
	(0.07)	(0.05)	(0.04)	(0.13)
Union X Size	0.975	0.962**	0.982	1.019
	(0.02)	(0.02)	(0.02)	(0.03)
Mine Size	0.869***	0.890***	0.925***	0.899***
	(0.02)	(0.02)	(0.02)	(0.03)
Log of Controller Size	0.943***	0.985**	1.047***	1.021
	(0.01)	(0.01)	(0.01)	(0.06)
Mine Age	0.999	0.999	0.999	1.007
	(0.00)	(0.00)	(0.00)	(0.01)
Productivity	0.994	0.997	0.997	0.942***
	(0.00)	(0.00)	(0.00)	(0.02)
Lost-Day Injuries in Prev. Year	1.000***	1.000***	1.000***	1.000
	(0.00)	(0.00)	(0.00)	(0.00)
Penalty Points in Prev. Year	1.000***	1.000***	1.000***	1.000***
	(0.00)	(0.00)	(0.00)	(0.00)
Longwall Indicator	0.914	0.898*	0.919	1.569
	(0.05)	(0.05)	(0.07)	(0.54)
Mining Subunit Dummies[a]	Y	Y	Y	Y
District Fixed Effects[a]	Y	Y	Y	Y
Quarter/Year Fixed Effects[a]	Y	Y	Y	Y
Observations	38,905	38,905	38,905	11,045
# of Union Mines / # of Total Mines	355 / 2,639	355 / 2,639	355 / 2,639	352 / 2,568

*Significance levels: *** 1%, ** 5%, * 10%. Standard errors, clustered at the mine level, are shown in parentheses.*
Results Presented: The information presented in this table is identical to that presented in the Baseline/Public-Fields column of Table 2, but includes additional coefficient estimates. Each value represents the IRR (incidence rate ratio)[a] coefficient on an independent variable in a negative binomial regression model. Hours worked is the exposure term.
Definitions: A quarterly FTE is defined as 500 hours worked.
Unit of Observation: The unit of observation is the mine-quarter for the non-traumatic, total, and traumatic injuries regressions. The unit of observation is the mine-year for fatality regressions.
Dependent Variables: The dependent variables are counts of injuries of each type (specified in the top row) that occur underground. *Traumatic injuries* are defined to include the following: amputations; enucleations; fractures; chips; dislocations; foreign bodies in eyes; cuts and lacerations; punctures; burns/scalds; crushings; chemical, electrical, and laser burns; and fatalities. (See footnote 13 for more details on the definition on traumatic injuries.) The sum of traumatic and non-traumatic injuries comprises *total injuries*.
Independent Variables: All models include the following regressors: union dummy, mine size (a continuous variable reflecting the mine's total number of FTEs), union X mine size, logged controller size (a continuous variable reflecting the controller's total number of FTEs), mine age, mine productivity, total lost-work injuries (in hundreds)

during previous calendar year (for fatality models) or previous four quarters (for non-fatality models), total penalty points (in thousands) during previous calendar year (for fatality models) or previous four quarters (for non-fatality models), dummies indicating presence of each respective mine subunit, quarter/year dummies, district dummies, longwall indicator, and a constant term. See Appendix C for complete variable definitions. An expanded version of this table, including a complete covariate report, is available at http://amorantz.stanford.edu/papers/union-coal-mine-safety/.
Sample: The sample consists of underground bituminous coal mines with positive coal production and positive hours worked, including all mine-quarters from 1993–2010. Because the historical variables (lost-work injuries and penalty points) are summed up over the previous four *quarters* in the non-traumatic, total, and traumatic injuries regressions but are summed up over the previous *calendar year* in the fatality regressions, some mines excluded from the fatality models are included in the other models. For example, if a mine is open for all of only one calendar year, it will have no historical data at the *yearly* level, but it will have historical data for three of the four *quarters* it was open. The number of union mines is computed by counting the mines that were unionized for any of the mine-quarters in the sample period. The total number of mines is computed by counting each mine in the sample, regardless of union status.
[a] A coefficient of 1 indicates no change at all in predicted injuries; coefficients between 0 and 1 represent a predicted fall in injuries (e.g. a coefficient of 0.97 represents a 3% decline); and coefficients greater than one represent predicted increases (e.g. a coefficient of 1.03 represents a 3% rise).

APPENDIX TABLE A3: FIXED EFFECTS MODELS

Specification:	Baseline (Hours Worked)		Employees		Tonnage	
Mine/Controller Size Units:	100 Quarterly FTEs		100 Employees		Millions of Tons	
Version:	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version	Public-Fields Version	Confid.-Fields Version
Non-Traumatic Injury Model	1.374***	1.091	1.385***	1.101	1.440***	1.103
	(0.14)	(0.15)	(0.14)	(0.15)	(0.13)	(0.12)
Total Injury Model	1.208**	1.056	1.205**	1.066	1.258***	1.063
	(0.09)	(0.11)	(0.09)	(0.12)	(0.09)	(0.09)
Traumatic Injury Model	0.896	1.037	0.882	1.058	0.971	1.032
	(0.09)	(0.12)	(0.09)	(0.14)	(0.08)	(0.10)
# of Observations	4,075	1,558	4,075	1,558	4,075	1,558
# of Union Mines / # of Total Mines	164 / 164	79 / 79	164 / 164	79 / 79	164 / 164	79 / 79
Fatality Model	0.381**	5.067	0.386**	2.607	0.423**	.[a]
	(0.17)	(9.08)	(0.17)	(3.88)	(0.18)	.
# of Observations	1,082	412	1,082	412	1,082	412
# of Union Mines / # of Total Mines	151 / 151	71 / 71	151 / 151	71 / 71	151 / 151	71 / 71

*Significance levels: *** 1%, ** 5%, * 10%. Standard errors, clustered at the mine level, are shown in parentheses.*

Limitations of Fixed Effects Model: Only a small proportion of underground coal mines (6.2%) changed union status during the period examined (1993-2010). Those that did change union status seem to be highly unrepresentative of the population as a whole: at least 19% of coal mines that de-unionized and 78% of mines that became unionized during the sample period experienced major disruptions (defined as production, employment, or hours worked dropping by over 50%; a year or more of inactivity; or change of the mine operator or mine controller) during the year when the transition took place. Any analysis predicated upon this idiosyncratic subgroup is likely to yield biased estimates of unionization's true effect, which is why I place this table in an appendix.

Results Presented: The table reports IRR (incidence rate ratio)[b] coefficients on the union indicator variables in negative binomial regression models. Hours worked is the exposure term.

Definitions: A quarterly FTE is defined as 500 hours worked.

Unit of Observation: The unit of observation is the mine-quarter for the non-traumatic, total, and traumatic injuries regressions. The unit of observation is the mine-year for fatality regressions.

Dependent Variables: The dependent variables are counts of injuries of each type (specified in the top row) that occur underground. *Traumatic injuries* are defined to include the following: amputations; enucleations; fractures; chips; dislocations; foreign bodies in eyes; cuts and lacerations; punctures; burns/scalds; crushings; chemical, electrical, and laser burns; and fatalities. (See footnote 13 for more details on the definition on traumatic injuries.) The sum of traumatic and non-traumatic injuries comprises *total injuries*.

Independent Variables: All models include the following regressors: union dummy, mine size (a continuous variable whose units are specified in column header), union X mine size, logged controller size (a continuous

variable whose units are specified in column header), mine age, mine productivity, total lost-work injuries (in hundreds) during previous calendar year (for fatality models) or previous four quarters (for non-fatality models), total penalty points (in thousands) during previous calendar year (for fatality models) or previous four quarters (for non-fatality models), dummies indicating presence of each respective mine subunit, quarter/year dummies, district dummies, and a constant term. Public-fields versions also include a longwall indicator. Confidential-fields versions also include the number of coal beds, mean coal bed thickness (in yards), subsidiary indicator, captive production as a percentage of total production, recoverable coal reserves, and mining method percentages. See Appendix C for complete variable definitions. An expanded version of this table, including a full covariate report, is available at http://amorantz.stanford.edu/papers/union-coal-mine-safety/.
Sample: The sample consists of underground bituminous coal mines with positive coal production and positive hours worked that switched union status at some point during the sample period. The public-fields versions contain mine-quarters from 1993–2010, whereas the confidential-fields versions are restricted to 1998–2010. Because the historical variables (lost-work injuries and penalty points) are summed up over the previous four *quarters* in the non-traumatic, total, and traumatic injuries regressions but are summed up over the previous *calendar year* in the fatality regressions, some mines excluded from the fatality models are included in the other models. For example, if a mine is open for all of only one calendar year, it will have no historical data at the *yearly* level, but it will have historical data for three of the four *quarters* it was open.
[a] Of the 412 mine-years in our sample for the confidential-fields version of the tonnage specification (rightmost column above), there were only 10 fatalities, which occurred in 5 unionized mine-years and 5 nonunionized mine-years. Because of the small sample size and lack of significant variation, the negative binomial regression did not converge for this model.
[b] A coefficient of 1 indicates no change at all in predicted injuries; coefficients between 0 and 1 represent a predicted fall in injuries (e.g. a coefficient of 0.97 represents a 3% decline); and coefficients greater than one represent predicted increases (e.g. a coefficient of 1.03 represents a 3% rise).

APPENDIX B: DESCRIPTION OF MODEL SPECIFICATIONS

The list below describes the three specifications and two versions that are included in Table 2.

Hours Worked (Baseline) Specification: Mine size is measured in units of 100 quarterly FTEs. Controller size is measured by the log of hours worked across all mines controlled by that controller, in units of 100 quarterly FTEs.

Employees Specification: Mine size is measured in hundreds of employees. Controller size is measured by the log of employees across all mines controlled by that controller, in hundreds of employees.

Tonnage Specification: Mine size is measured in millions of tons. Controller size is measured by the log of tonnage across all mines controlled by that controller, in millions of tons.

Public-Fields Version: All models include the following regressors: union dummy, union-size interaction term, mine size measure (defined as specified in column headers or the table note), logged controller size measure (defined as specified in column headers or the table note), mine age, mine productivity, number of lost-work injuries (in hundreds) in the previous calendar year (for fatality models) or previous four quarters (for non-fatality models), total penalty points (in thousands in the previous calendar year (for fatality models) or previous four quarters (for non-fatality models), a constant term, dummies indicating presence of each type of mine subunit, quarter/year dummies, district dummies, and a longwall indicator.

Confidential-Fields Version: All models include the following regressors: union dummy, union-size interaction term, mine size measure (defined as specified in column headers or the table note), logged controller size measure (defined as specified in column headers or the table note), mine age, mine productivity, number of lost-work injuries (in hundreds) in the previous calendar year (for fatality models) or previous four quarters (for non-fatality models), total penalty points (in thousands) in the previous calendar year (for fatality models) or previous four quarters (for non-fatality models), a constant term, dummies indicating presence of each type of mine subunit, quarter/year dummies, district dummies, number of coal beds, mean coal bed thickness (in yards), subsidiary indicator, captive production as a percentage of total production, recoverable coal reserves, and the mining method percentages.

Appendix C: Variable Dictionary

Variable Name	Variable Definition	Source
Non-traumatic injuries	Total number of injuries not classified as traumatic	MSHA
Total injuries	Total number of injuries and fatalities reported	MSHA
Traumatic injuries	A subset of injuries that are least prone to reporting bias (see footnote 13)	MSHA
Fatalities	Total number of fatalities reported	MSHA
District dummies	1 if mine is located in a given MSHA district, 0 otherwise	MSHA
Ln (Controller Size)	Log of controller size measure. Controller size measure is either 100 FTEs, 100 employees, or one million tons	MSHA
Lost-workday injuries	Lost-workday injuries are those that result in time lost from work. When included as a regressor, it is the number of such injuries in the previous calendar year (for fatality models) or previous four quarters (for non-fatality models), in hundreds.	MSHA
Mine age	Age of mine in years since the first operator began work at the mine (top censored at 1970)	MSHA
Penalty Points	Thousands of penalty points in the previous calendar year (for fatality models) or previous four quarters (for non-fatality models)	MSHA
Productivity	Thousands of tons of coal produced per annual FTE (2,000 hours)	MSHA
Quarter/year indicators	1 if observation is for a given year or quarter, 0 otherwise	MSHA
Size Measure	Size measure is either 100 FTEs, 100 employees, or one million tons	MSHA
Subunit indicator	1 if mine contains a given subunit, 0 otherwise Subunit types include e.g. “surface” and “mill or prep plant”	MSHA
Mean coal bed thickness	The mean thickness of all coal beds at the mine, in yards	EIA*

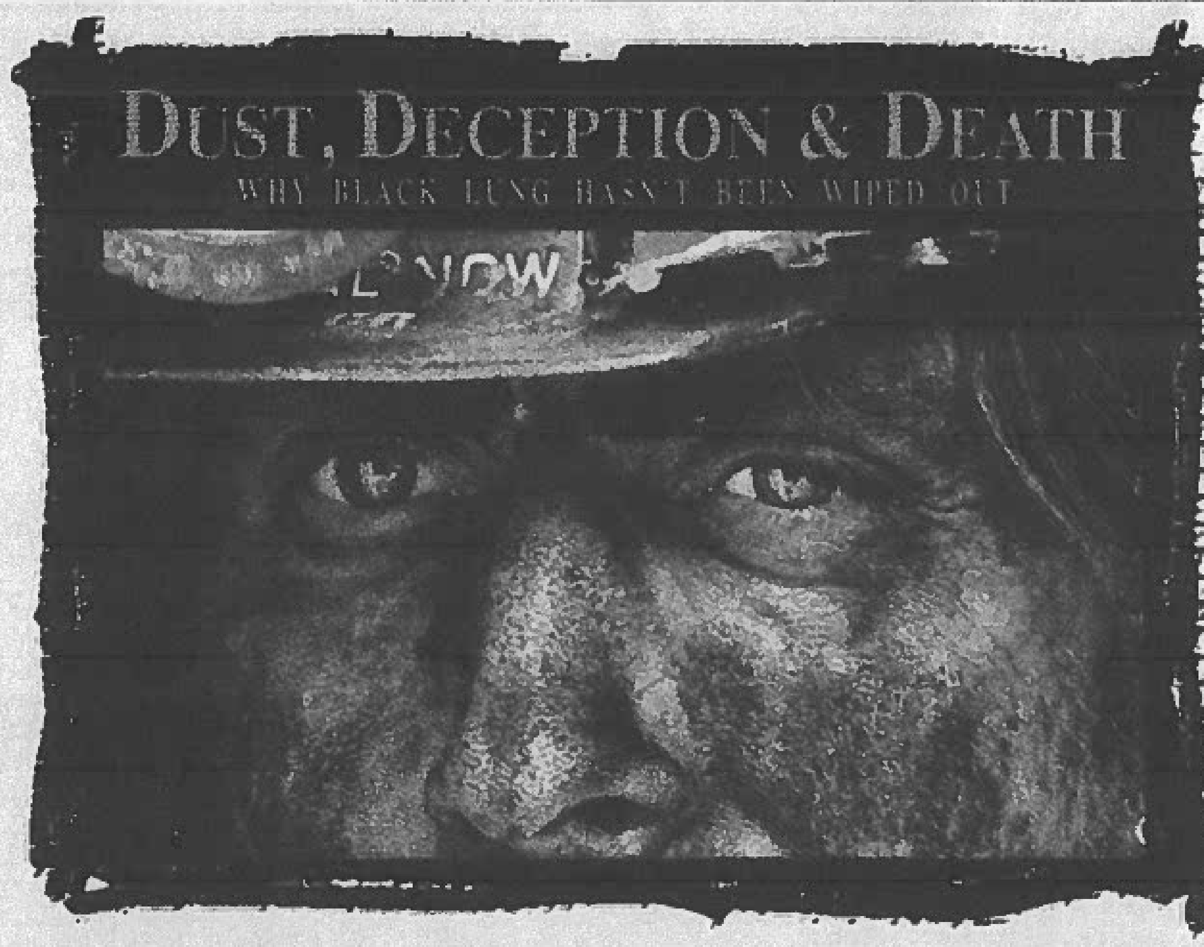
Mining method percentages	Proportion of underground operation that uses a given mining method, expressed as fraction between 0 and 1; types include conventional, continuous, longwall, shortwall, and other	EIA
Number of coal beds	Number of coal beds at the mine site	EIA[a]
Percent captive production	Percent of production for mine or parent company's own use	EIA[a,b]
Recoverable reserves	Estimated tonnage of remaining coal reserves	EIA[a,b]
Subsidiary indicator	1 if mine is a subsidiary of a larger firm, 0 otherwise	EIA[a]
Union indicator	1 if mine is unionized, 0 otherwise	EIA
Longwall Indicator	1 if mine is a longwall mine, 0 otherwise	NIOSH

Source: MSHA inspection records, 1993–2010; EIA coal mine data 1993–2010; NIOSH coal mine data 1993–2010.

[a] These data fields were obtained on a confidential basis, and are considered trade secrets by the companies that provided them.

[b] These data fields are unavailable prior to 1998.

Attachment
17

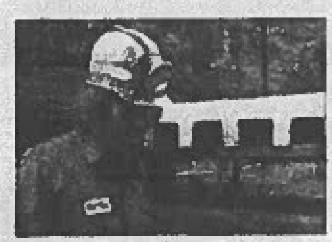


A disease's deadly grip

STORIES BY GARDINER HARRIS AND RALPH DUNLOP ■ PHOTOGRAPHS BY STEWART BOWMAN

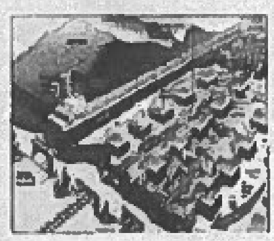
EVERY YEAR, black-lung disease kills almost 1,500 people who have worked in the nation's coal mines. It's as if the Titanic sank every year, and no ships came to the rescue. While that long-ago disaster continues to fascinate the nation, the miners slip into cold, early graves almost unnoticed.

In a five-part series starting today, *The Courier-Journal* reveals why so many miners are dying — more than a century after doctors learned that coal dust kills and 28 years after Congress passed a law to wipe out black lung. ■ SECTION K



WIDESPREAD CHEATING: Black lung kills hundreds of miners each year because many operators, helped by some miners, conceal lethal levels of dust by cheating on tests. **Stories, K1 and K3**

IN THEIR OWN WORDS: *The Courier-Journal* interviewed 255 working and retired miners, who talk about life in the mines. **The Voices, K2-4**



ANATOMY OF A COAL MINE: An in-depth look at how a mine operates and how the ventilation system is supposed to work. **Graphic, K5**

A FIVE-PART SPECIAL REPORT:

- How and why mines cheat on dust tests
- Lack of government oversight
- The role of mine operators
- Problems with workers' compensation
- Solving the problems

The Courier-Journal

SUNDAY, APRIL 19, 1998 ■ SECTION K

DUST, DECEPTION & DEATH

WHY BLACK LUNG HASN'T BEEN WIPED OUT

Cheating on coal-dust tests widespread at nation's mines

A VICTIM

A closer look at people who gave their lives to the mine

Dying at 45, a former miner exists breath to breath

By GARDINER HARRIS
The Courier-Journal

LOGAN, W.Va — Leslie Blevins stumbles out of the bathroom and struggles with the oxygen tube hanging on the door.

His hands shake so violently that he has trouble putting the forked tube into his nose. Wide-eyed with desperation, he finally inserts it, then collapses on a nearby couch.

His hair is wet, his face flushed, his eyes watering. He coughs and gasps as if he's been punched in the gut.

Blevins, 45, has just taken a shower.

The former coal miner is dying of silicosis, a virulent form of black-lung disease. A year ago, Blevins was slowly walking six miles a day. By July, he could manage just two miles. Last fall, he had trouble walking from bedroom to living room. Now he spends most days in bed.

> "It's something I always wanted to do. Dad worked in the mines, Grandpa worked in the mines. It's what was here."
>
> — LESLIE BLEVINS, AGE 45

A doctor told him in 1995 that if he quit mining he might live two more years. He outlived that prediction and hasn't asked for another: "I don't want to know. I'll just take it as it comes."

Blevins worked underground for 21 years as a mining-machine operator, one of the most dangerous and dusty jobs in America. His lungs are black, but it's not coal dust that's killing him. For three months in late 1993 and early 1994, he cut through sandstone to get to a coal seam. Sandstone's silica-laden dust is much more damaging to lungs than coal dust.

"I knowed I'd pay for breathing all that dust," Blevins said. "I just didn't think it'd be this quick."

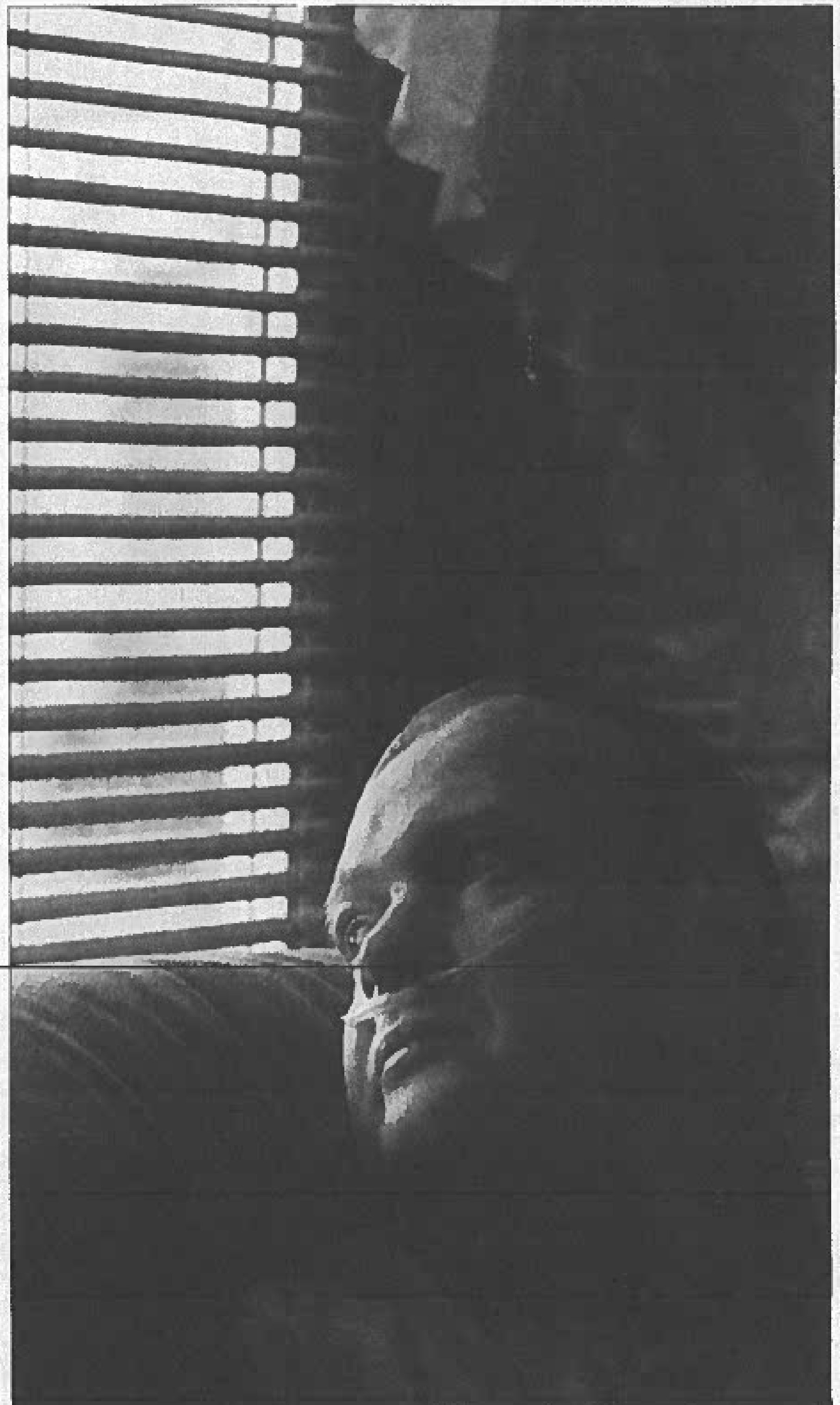
Blevins and his wife, who have two children, are driving to Morgantown, W.Va., on this day to see his doctor. Linda Blevins, 41, packs the car. Then she and her husband, who heaves from the effort, wrestle a 40-pound oxygen tank into the back seat.

As they drive off, the car fills with the sweet, intoxicating smell of fresh oxygen. They pass the coal trains that coat their house with black dust each night, then settle in for the four-hour drive. Without noticing, they pass an exit that leads to Hawk's Nest, where the world first discovered how quickly silicosis can kill.

From 1930 to 1933, an estimated 764 laborers — mostly black migrants from the South — contracted silicosis while digging a tunnel for Union Carbide.

Still the worst industrial disaster in

See HE TAKES
Page 5, col. 1 this section



BY STEWART BOWMAN, THE COURIER-JOURNAL

Leslie Blevins, a former coal miner, is dying of silicosis, a virulent form of black-lung disease. A year ago, he could slowly walk six miles a day. Now he views the world through a window, and spends most days in bed.

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DUST, DECEPTION & DEATH

PEOPLE WHO GAVE THEIR LIVES TO THE MINE

"There would be times when I took company samples and the foreman would come over and turn" off the sampling machine. "Or I'd come out of the mine, and they'd say, 'You took a sample today.' And I'd say, 'I did? Where was it?' And they'd say, 'In the intake (clean air).' "

— LESLIE BLEVINS,
who worked underground 21 years
as a mining-machine operator

He takes each day one breath at a time

Continued from Page One

American history. Hawk's Nest is notable not only for the number of dead but also for the swiftness with which they died. Black lung usually takes years to kill. At Hawk's Nest, workers were dying within months.

The tragedy has long been discussed as a rare example of corporate negligence, but Blevins' story shows that similar, if smaller, disasters still kill Appalachian miners.

Once Linda Blevins passes the Hawk's Nest exit, she is hemmed in behind a truck spewing black exhaust. The smell fills the car.

"Linda," Leslie Blevins pleads, gripping the hand-hold above the door. The "chuh, chuh, chuh" of the oxygen tank increases; Leslie Blevins is laboring for breath.

Intense smells restrict his breathing. No one in his family is allowed to wear perfume or use strong-smelling soaps. His wife can no longer fry foods. They have stopped visiting the homes of smokers. Candles bother him. Fires and exhaust torture him.

A slow-moving van in the left lane is blocking Linda Blevins from passing the truck. "Get out of the way!" she shouts. She is frantic. She tries to close vents, but the smell increases. Her husband's face is pale. His eyes are scared.

Suddenly, an opening. She guns the Taurus past the van and truck. The smell fades, and as it does her husband's breathing slows. He drops his hand to his lap and sits back in his seat, motionless, exhausted.

A FAMILY OF MINERS

His boyhood home was just a stone's throw from mine

Blevins was once a vibrant, fidgety man. The year after his condition forced him to retire in November 1995, he would pace his home. Even last April, he would pop up every few minutes while watching TV to look in the refrigerator or glance out the bedroom window. While seated, he would bounce one foot. He would talk a lot, his dark eyes sparkling.

He still spends most of his days watching TV, but he doesn't fidget, doesn't bounce his foot, doesn't get up much, doesn't say much. His face is swollen from steroid treatments. His once formidable muscles are withered.

His mental energy has waned. He lives less in the present, his mind distracted by his slide toward death. His father and his oldest brother, Virgil, also have black lung, but Blevins will likely be the first to die.

Blevins grew up in the Pine Creek coal camp outside of Logan, which once had nearly 300 houses. His home was a rock throw from the mine, and most days after school "we'd sneak down the slope and wait for the engine to come up pulling the coal.

"And the kids, we'd get up on the motor and when it got out, we'd throw off some big pieces of coal to [illegible] and we'd take them around to the homes that needed coal."

After high school, he, Virgil and a cousin enlisted in the Army together. Three years later, he came home and married Linda. In 1972, after a year of working odd jobs, he was hired at a union mine working a 36-inch-high seam of coal. He was 21.

"It's something I always wanted to do," Blevins said. "Dad worked in the mines. Grandpa worked in the mines. It's what was here."

Working a low coal seam is a bit like spending the day shoveling under a dining room table. By the end of his first day, he was so sore from stooping and crawling he couldn't straighten. He crawled home.

"On the fourth day, I was down on my knees shoveling when the roof fell in. It broke my left foot and the toes on my right foot." When he healed, he went back underground because he loved it.

"I'd go back today if I could," Blevins said.

Then, in 1993, the mine closed. He was unemployed for six months until landing a job at a nearby non-union mine, RMI Contracting, as a mining-machine operator. The coal seam was 7 feet high; he could finally stand while working. But his pay dropped — to $11.25 an hour from $16.52.

He mined the seam for about a month, then it unexpectedly turned into a wall of sandstone. Blevins was told to cut through to the coal. "They cleared everybody else out because they wanted them doing other things," he said.

ON A GOOD DAY, Leslie Blevins would strap on his oxygen tank . . .

He started coming home covered in white dust and looking exhausted, Linda Blevins said. "He'd come home, get in his chair and fall asleep. I'd have to wake him up to feed him dinner, and then he'd go right back to sleep."

Blevins knew rock dust was particularly unhealthy — even the ancient Greeks knew about silicosis, the oldest known occupational disease. But he didn't complain.

"There's a lot of things that wasn't supposed to be done, but you either do it or you went home," Blevins said.

To keep his job, he helped conceal his sandstone mining from federal inspectors, who would have insisted on strict precautions if they had known about it. "If a mine inspector showed up, they (his bosses) would tell me to quit, shut off the power to the area and go some place else to work," Blevins said.

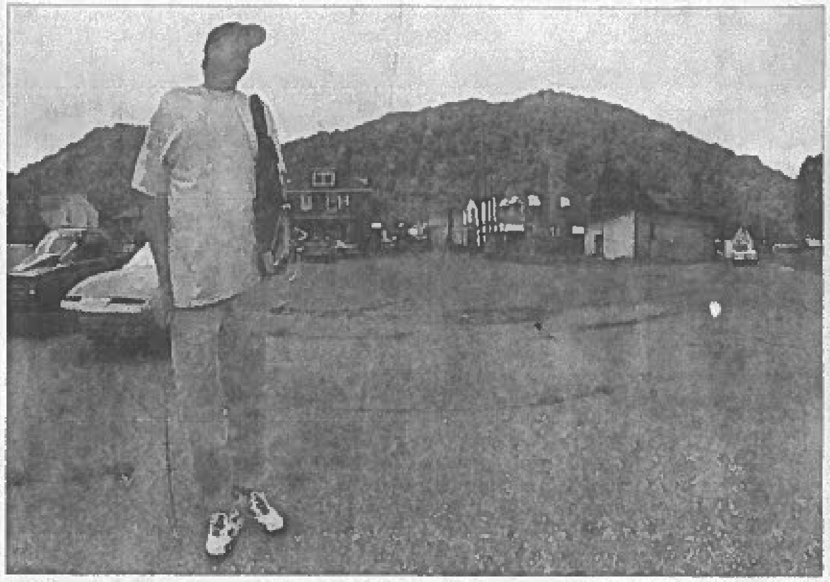
Mine operators are required to test the air every two months to make sure dust levels don't exceed federal limits. But Blevins said he never took a dust test while working the sandstone. In fact, he said he never took a proper dust sample the entire two years he was at RMI.

"There would be times when I took the company samples, and the foreman would come over and turn off the sampling machine," Blevins said. "Or I'd come out of the mine, and they'd say, 'You took a sample today.' And I'd say, 'I did? Where was it?' And they'd say, 'In the intake.'" The intake is a channel bringing fresh air into a mine.

During the three months Blevins was cutting through rock, RMI took 12 dust samples, according to federal records. The samples were supposed to be taken where mining-machine operators such as Blevins were working. But nine of the tests had just 0.1 mg. of dust per cubic meter of air — readings so clean that experts say they must be inaccurate.

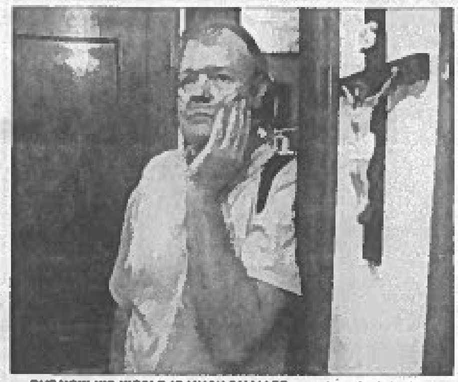
Tests supervised by government inspectors from 1991 through 1993 showed higher amounts of silica dust. The mine was cited four times in those years for exceeding federal dust limits and was fined a total of $1,681.

Three RMI officials refused comment when reached by telephone.



. . . AND GO FOR A WALK. A year ago, he enjoyed strolling through his neighborhood. As time passed he could barely walk a block.

ON BAD DAYS, when Blevins could not leave the house, Latern Jenkins, the newspaper carrier, would bring the paper inside . . .



. . . BUT NOW HIS WORLD IS MUCH SMALLER, with the task of simply moving from room to room a major chore . . .

A LIFE UNDERGROUND

More near-death stories than even a war hero

[illegible] vinans stop to eat and service the car, Linda Blevins pumps the gas.

"I can't stand the smell of gas, either," Leslie Blevins says with an apologetic shrug.

These are the moments that gnaw at Blevins. He used to be the one who drove, who always filled the tank. "For a long time, Linda didn't even need a driver's license," he said.

But Blevins' lungs may collapse any time now, and his wife doesn't want him behind the wheel when it happens. It's a disconcerting turn for a proud man who grew up in a culture with strictly defined roles. Men drive.

Mining fueled this macho culture, historians say, because it's difficult to spend a lifetime underground without it. Blevins, for instance, has more near-death stories than a war hero.

"I had this new helper one time, and I told him, 'If you hear timbers breaking, run,'" Blevins said one day. "Later on, the timbers start to go and this guy freezes. I slump down under the miner (machine). When the dust clears, there's this huge rock between me and this guy. He's just frozen. He walked out and never came back."

Blevins can tell stories like that for hours. There was the time he pulled back another helper just as he heard the roof pop, saving the man but slicing his own hand in the process. The time his foreman was killed and his cousin maimed when a pillar of coal collapsed. The time a backing mining machine pinned him to the roof and dislocated his shoulder.

And each time Blevins went back to work to provide for his family. He did it because, in his view, that's what a man does. He mines coal, hunts deer, and is served dinner when he comes home.

Now Linda Blevins brings home the family paycheck working as a secretary for the local school board, and the boys take-out food.

Leslie Blevins knew that mining might one day cost him his life.

"I accepted that my lungs are bad and would cut my life short," said Blevins. "But it's hard for me to accept that I can't hunt and do things with my family like I used to. That's what bothers me."

This feeling of inadequacy is one of the reasons that he fought for four months for workers' compensation — enduring pokes and prods from doctors and prying questions from lawyers. Of course his family needs the money, but a monthly compensation check also allows Blevins to support his wife and children the way he believes a man ought to.

Just 7.5 percent of applicants for federal black-lung benefits succeed. Blevins was one of the lucky ones. He was awarded $779 per month in April 1996.

. . . AND LIFE IS OFTEN VIEWED FROM THE SOFA, where Blevins keeps his oxygen close at hand. Some days he doesn't even make it out of bed, and his meals are brought to him.

THE MAN VS. MACHINE

An angry wife believes his bosses sacrificed him

Back on the road, Linda Blevins brings up their success at winning benefits. "It seems like every time the devil tried to pull something, the Lord would show us the way," she says.

Her husband looks out his window when his wife says this. Never a church-goer, Leslie Blevins is somewhat bemused by his wife's increasing religious devotion. When she talks at length about what the Lord has shown her, he pipes up, "The Lord should be telling you to cook more, Linda."

Linda Blevins' growing faith has helped her cope with an anger that last year threatened to consume her. She was outraged that her husband's bosses had, in her view, sacrificed him to save a machine.

When he started cutting into the sandstone, Blevins was using a relatively new mining machine with a remote control that allowed him to stand out of the worst of the dust.

But sandstone is much harder than coal, and the work was tearing the machine apart.

The owners decided to sell the machine while they could, and they took an older one out of the shop, Blevins said. This one had no remote, so he was forced to sit on the machine in the dust. The machine would shake so violently that it would sometimes throw Blevins against the mine roof, he said. Its water sprays — used to suppress dust — were constantly breaking. The dust was suffocating.

"Sometimes I'd have to shut the miner down and go back in the fresh air and puke," Blevins said. "My boss would come back and tell me to go back in."

Linda Blevins is increasingly serene about this. And her equanimity has helped keep the family together. Bryan, 21, lives in Ohio and comes home on weekends. Lynn, 19, decided against going away to college because of her father's failing health.

Linda Blevins said her faith also helps her to worry less about the future. Yet the thought of losing her husband brings on despair.

Leaning against the kitchen stove one day, she said, "I've been here alone before and thought, if this is what it's going to be like, I don't want him to leave me. I don't want him to go."

AN EYE ON DEATH

With no miracles, doctor watches disease progress

When they arrive at the doctor's office in Morgantown, Linda Blevins goes to the counter while her husband stares out a window at the West Virginia University football stadium. In yet another indignity, the doctor [illegible] government health-insurance card, because his black-lung benefits cover only a small portion of the bills. The visit will be paid for by Linda Blevins' insurance through her work.

Leslie Blevins is ushered into an examination room. Dr. Daniel Banks shows up a moment later. A gentle man with round glasses, Banks asks Blevins about his family and his feelings. He takes note of his symptoms and is concerned that his patient has developed a bad cough.

Banks has Blevins walk around the office attached to a monitor to see how quickly his blood loses oxygen. The results are disheartening. Banks tells Blevins to make sure his oxygen is turned all the way up at all times.

With that, the visit is over. It's been less than 30 minutes. Banks can do little for Blevins. He's already prescribed the steroids and oxygen. Like the man behind the curtain in the "Wizard of Oz," he has no more tricks to dazzle the travelers.

"At this point, we're just watching the natural progression of the disease," Banks says.

The Blevinses quickly get on the road back to Logan. They drive mostly in silence.

"Just once," Leslie Blevins says to break the quiet, "I'd like to get some good news at the doctor."

Despite laws, hundreds are killed by black lung

First of five parts

By GARDINER HARRIS
The Courier-Journal

HUNDREDS OF coal miners nationwide die each year of black-lung disease because many mine operators, aided by miners themselves, cheat on air-quality tests to conceal lethal dust levels.

And while the federal government has known of the widespread cheating for more than 20 years, it has done little to stop it because of other priorities and a reluctance to confront coal operators, an investigation by The Courier-Journal shows.

"Yes, even a cursory look (at federal dust-test records) would lead one to believe that inaccurate samples continue to be submitted in large numbers," said J. Davitt McAteer, the government's top mine-safety official.

The result: Many underground miners toil in coal dust so thick that over the years their lungs become choked with scars and mucus, and they eventually suffocate.

In 1969, Congress placed strict limits on airborne dust and ordered operators to take periodic air tests inside coal mines. The law has reduced black lung among the nation's 53,000 underground coal miners by more than two-thirds. But because of cheating, the law has fallen far short of its goal of virtually eliminating the disease.

The number of sick miners is unknown, but government studies indicate that between 1,000 and 3,000 working miners — and many retirees — have one of the lung disorders collectively called black lung.

In a year-long investigation, The Courier-Journal interviewed 255 working and retired miners in the Appalachian coal fields and analyzed by computer more than 7 million government records. Unearthed was a mountain of evidence that cheating is widespread.

The findings:

WIDESPREAD FRAUD: Nearly every miner said that cheating on dust tests is common, and that many miners help operators falsify the tests to protect their jobs.

"I've never known of one to be taken right, and I was a coal miner for 23 years," said Ronald Cole, 62, of Virgie, Ky., who left the mines in 1994. Like many of the miners interviewed, Cole has black lung.

Two dozen former mine owners or managers acknowledged that they had falsified tests.

TAINTED TESTS: Most coal mines send the government air samples with so little dust that experts say they must be fraudulent.

LAX ENFORCEMENT: The Mine Safety and Health Administration ignored these obviously fraudulent samples for more than 20 years, until The Courier-Journal began asking about them late last year. The agency also paid little attention during the 1970s and 1980s to government auditors and outside experts who repeatedly warned about dust-test fraud.

BOTCHED INSPECTIONS: Agency inspectors oversee tests at least once a year, but these tests also have been inaccurate. Many inspectors fail to closely supervise the miners taking these tests, and since 1992, 11 inspectors have been convicted of taking bribes. In recent years, the government has improved its test monitoring, because the agency is now headed by McAteer, a longtime mine-safety advocate. Yet even today tests that are overseen by inspectors rarely measure the dust levels that miners actually breathe.

THE UNION FACTOR: Dust tests tend to be taken more accurately at union mines than at

See CHEATING
Page 4, col. 2 this section

Cheating on dust tests is widespread

Continued from Page One

[illegible]

DIRTY SURFACE MINES: Dusty conditions and cheating on tests are also common at surface coal mines, and strip mine drillers are especially at high risk.

BETRAYED MINERS: Many miners who develop black lung feel betrayed by the state and federal governments when, after years of keeping mine operators cheat, they are denied disability payments.

In Kentucky, legislators — at the urging of Gov. Paul Patton, a former coal operator — passed a workers' compensation law in 1996 that made it tougher for black lung victims to qualify for benefits. The law has cut insurance premiums of some coal companies by almost half.

"The dust-testing system has been rife with fraud from day one," said Tony Oppegard, [illegible] the Kentucky-based Mine Safety Project, which represents miners with safety complaints. "It's a national tragedy and a national disgrace."

But coal industry representatives say cheating and dangerous dust levels are isolated problems. They blame most miners' lung disease on smoking. While smoking is common among miners, medical research shows that coal-mine dust damages lungs in similar ways.

"We have been the victims of allegations of fraud and cheating and not caring about miners since day one," said Bruce Watzman, vice president of health and safety for the National Mining Association. "... That's not true of this industry."

Mine-safety advocates and small numbers of miners have said for years that cheating on dust tests was the reason black lung had not been wiped out. But the coal industry has always flatly denied that, the government has largely ignored them, and most miners have been afraid to accuse their employers of cheating.

The mine-safety agency did accuse hundreds of mine operators in 1991 of tampering with dust tests during the previous two years, but it failed to prove its case in court, and most of the civil charges were dismissed.

EVIDENCE OF FRAUD

Scores of miners say tests were always rigged

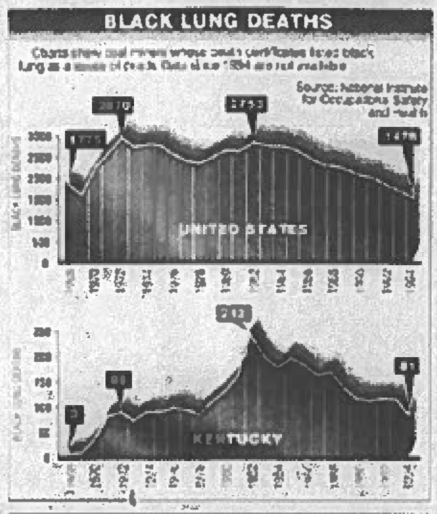
The Courier-Journal has now amassed evidence that dust-test cheating is widespread and has existed much longer than the mine-safety agency ever alleged or openly acknowledged.

[illegible]

Second-shift miners emerge from the Island Fork Construction No. 4 mine in Floyd County, Ky. They had labored eight hours in a 4-foot-tall seam. The average height of mines in central Appalachia is 4 feet.

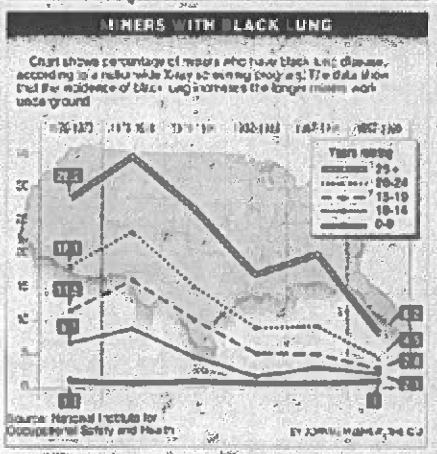
BLACK LUNG DEATHS

Charts show coal miners whose death certificates listed black lung as a cause of death. Data since 1994 are not available.



MINERS WITH BLACK LUNG

Chart shows percentage of miners who have black lung disease, according to a nationwide X-ray screening program. The data show that the incidence of black lung increases the longer miners work underground.



[illegible] miners have been disabled or died.

Between 1972 and 1994, the deaths of 51,288 U.S. miners — 3,975 in Kentucky — were blamed at least partly on black lung. [illegible]

[illegible] mine-safety agency and the public. But regulators' focus on accident fatalities ignores a simple fact: Black lung displaced accidental deaths as the principal killer of miners at least [illegible]

[illegible]

SAFETY VS. DISEASE

Accidents overshadowed deaths from black lung

[illegible]

who had started work after the new dust limits went into effect in 1972.

For example, Ben Vanover didn't start mining until 1973. By 1985, after working for seven different coal companies, his breathing was so bad that he would often drop to his knees and lean against the mine wall to catch his breath. He quit. The Mine Act proclaims that miners should be able to work their entire adult lives — 45 years — without fear of getting black lung. Vanover, 53, of Stambaugh, Ky., made it just 12 years.

The Floyd County resident, who says he quit smoking in his 20s, now sleeps with an oxygen tank but still wakes up two or three times a night, gasping for air. In a recurring nightmare, he's being pulled underwater.

"You don't think too much about it when you go into the mines, but once your breathing gets bad you realize you made a mistake. By then you already got it, and it's too late."

[illegible]

LIVES VS. PROFITS

Trying to run a mine, make money, pass tests

[illegible]

HOW MINES CHEAT

In search of 'good' results: Coffee cans to lunch pails

[illegible]

[illegible]

CHOKING DUST LEVELS

'Your throat gets dry and scratchy and full of grit'

[illegible]

DUST, DECEPTION & DEATH

ANALYZING HOW THE TESTS ARE DONE

"If miners were working with proper ventilation, they wouldn't come out of the mines with coal-black faces. But go to any mine in any hollow in Eastern Kentucky and tell me how many miners you see at the end of their shift with clean faces."

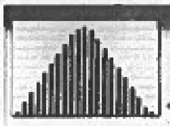
— Tony Oppegard, directing attorney of the Mine Safety Project, Lexington, Ky.

Low dust levels: 'Unfathomable'

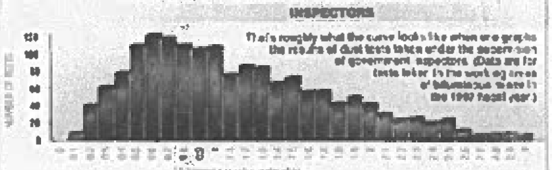
Most mine tests about as dirty as street corner

MINES WITH LOW DUST TESTS

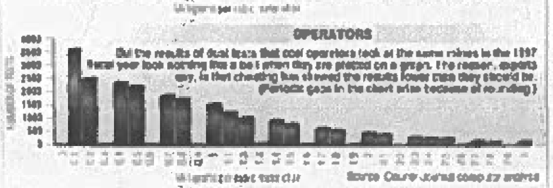
FALSIFIED TESTS



INSPECTORS



OPERATORS



DUST TESTS BY STATE

THE FACE

The coal-blackened face used as the symbol of this series belongs to Johnny Hurley, 30, of Majestic, in Pike County, Ky. Hurley, who has been a miner for 12 years, was photographed after emerging from the Crystal Fuels No. 1 mine in Lobata, W. Va.

Crystal Fuels is a subsidiary of A.T. Massey Coal Co., the nation's 12th largest coal producer. In the 1997 fiscal year, Crystal Fuels took 45 dust samples at the mine face, where the coal is dug. Thirty-four of those samples, or 76 percent, contained just 0.1 mg. of dust per cubic meter — a level that experts say is impossible to achieve in a bituminous coal mine.

Asked why the faces of Hurley and other miners were so dusty when the test results showed nearly clean air inside, the mine superintendent, Gary Meade, said he regretted allowing a photographer to take the miners' pictures.

"We're doing everything we're supposed to do," said Meade. "I can walk inside and come back coal-black because you sweat and wipe your face."

Meade said the tests are taken accurately "as far as I know. I don't go in there with them. . . .

"I'm a Christian man," he added. "I don't have anything to hide."

Johnny Hurley

THE VOICES

MAX MUSIC, 57, of Prestonsburg, Ky., a foreman for 14 years and a superintendent for 18 years. He left the mines in 1996 and has black lung.

"You can't run coal and pass those dust tests . . . and make a profit. You can't. All these men that work in these mines, they realize it. . . . If a few years on down the road they can't breathe, that's just tough.

"If you're running the continuous mining machine on a section, you're not going to keep the (ventilation) curtains up on that machine. And it's so doggone dusty there's no way you are going to get a good dust sample unless you're not mining the coal. . . . If you've got all the water you're supposed to have on the miner and all the air you're supposed to have up there, you've still got too much dust. . . .

"The whole thing (dust-sampling program), it's a big joke. You know, as long as there is a federal inspector there looking at a miner-operator, he (the miner) probably will leave it (the air sampler) alone. Otherwise he won't. Because you just don't get bad samples and stay with these companies. They will fire your butt. . . ."

MACK BROCK, 47, of Putney, Ky., miner for 24 years.

"They (dust tests) are not done right. (Miners) hang them up at the power box most of the time or at the dinner hole. They are advised to do that. The foreman usually takes care of that. Everyone knows about it. . . .

". . . that's his job. He has to get a dust test that passes. If he don't, they shut it down. He don't have to say nothing, you know, miners more or less takes care of the dust pumps theirselves. . . . You do whatever you have to do."

DUST, DECEPTION & DEATH

THE PROBLEMS AT ABOVE-GROUND MINES

Surface-mine drillers face high risk

Rate of disease at strip mines alarms officials

By GARDINER HARRIS
The Courier-Journal

THE MOST dangerous job in coal mining may not be underground.

Miners who spend at least 20 years as strip-mine drillers have a 61 percent chance of contracting silicosis, a virulent form of black lung. No other job in coal mining has such a high risk.

That number is based on a government-sponsored study of surface miners in western Pennsylvania's bituminous coalfields. The study is supported by other recent surveys of surface miners, and the startling results have researchers and government officials worried.

"The disease rates we found among drillers were simply unacceptable," said Joe Cocalis, an industrial hygienist with the National Institute for Occupational Safety and Health (NIOSH). "We've got a damn epidemic on our hands that is 100 percent preventable."

It's an epidemic that experts say could have been prevented by a few simple precautions by coal operators and better monitoring by the federal government.

In the 1970s and 1980s, the government believed that surface miners didn't suffer much from black lung. Then, in 1992, government researchers discovered that strip miners were dying of silicosis, a type of black lung caused by breathing rock dust with silica in it.

The Pennsylvania study, conducted in 1996 by doctors at Pennsylvania State University and NIOSH, helps confirm this discovery. The results will be formally presented at a meeting of the American Thoracic Society next week in Chicago.

Its findings show that, overall, 60 of the 667 strip miners in the study — 9 percent — had symptoms of silicosis, with drillers being the most at risk.

Smaller surveys in recent years of strip-miners in West Virginia and Wyoming also found that about 9 percent of each survey's participants had black lung.

"We have a hellova problem, and we have to work on it," said J. Davitt McAteer, assistant labor secretary for mine safety and health. "We should not have any cases of silicosis at all."

Interviews with miners and researchers suggest that the factors that cause black lung in strip miners are similar to the ones that have created problems for underground miners:

- Many strip-mine operators don't control dust properly and some cheat on dust tests.
- Miners, fearful of losing their jobs or mines closing, don't complain about the dusty conditions.
- Government has been slow to act. Only in recent years has it taken action to correct these conditions.

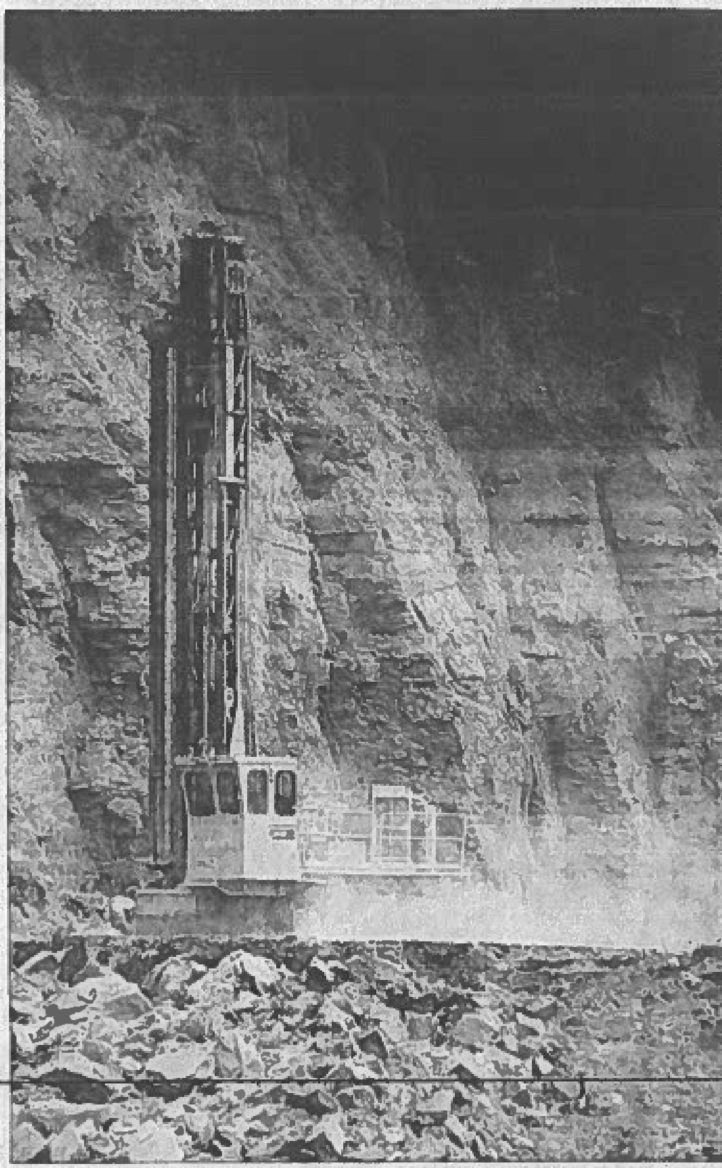
The federal Mine Safety and Health Administration for years didn't believe that black lung was a problem among strip miners, so the agency didn't put much effort into preventing the disease.

For instance, unlike underground miners, most strip miners aren't offered free chest X rays. Underground mines also must test dust levels every other month, but not strip mines, which are exempt unless they fail a test supervised by a federal inspector.

While tests overseen by federal inspectors are being increased from once to twice a year at surface mines in some states, air in underground mines will be tested four times a year.

The few tests taken at strip mines indicate serious dust problems. Before 1994, 75 percent of the air-sampling devices placed on drillers showed excessive levels of silica-laden rock dust, according to Dr. Jack Parker, chief of the examination processing branch of NIOSH.

But throughout the 1970s and 1980s, the average fine for failing a dust test was less than $100, according to The Courier-Journal's analysis.



BY STEWART BOWMAN, THE COURIER-JOURNAL

Coal dust is not only a problem underground. Strip miners also work in dusty conditions. One study in western Pennsylvania showed that strip-mine drillers had a 61 percent chance of getting black lung.

THE HIGHEST RISK

Operators of the drills face the gravest danger

Alan Coots, a drill operator from Leslie County, Ky., said that when dust-suppression equipment breaks, mine operators often don't want to lose production time to fix it. Coots, 35, said his boss at Hannco Energy's Knott County mine repeatedly assigned him to a drill with faulty dust equipment in 1995 and 1996.

"Nothing worked right on it," Coots said in an interview. He said dust routinely coated his throat.

Drillers bore holes for explosives, which shatter the rock covering a layer of coal. The drills are supposed to have curtains and blowers to protect the operator from rock dust, but the equipment fails if not serviced often.

Coots filed a complaint with the Mine Safety and Health Administration, and Hannco was fined $6,814. The agency later cut the fine in half. Hannco paid Coots and his lawyer $7,500 to settle his complaint.

A co-owner of Hannco, Tim Fugate, said the dust-fighting equipment on Coots' drill broke just before Coots quit his job. He denied Coots routinely worked on a dusty drill.

But Hannco also had been cited four times in 1995 and three times in 1994 for operating dusty drills, and paid $958 in fines.

Coots now works for another strip-mine company but said he regrets complaining. He fears mine operators will brand him a troublemaker.

A LOW PRIORITY

A flawed study shaped complacency on black lung

Complacency about black lung among strip miners was fueled in part by a botched NIOSH study in 1978. Researchers found relatively low rates of disease among surface miners overall — 2 percent to 5 percent had black lung — but they didn't look separately at the results for drillers or driller helpers. If they had, they would have seen a large number of the drillers had silicosis, according to Parker of NIOSH.

"We blew it," he said.

A year later, a 29-year-old drill operator appeared at West Virginia University Hospital in Morgantown with acute silicosis. He died in a few years.

His doctors, some of whom also worked at nearby NIOSH, were shocked. They inspected the strip mine where the man had been a driller for five years and found dusty conditions. They checked nine of his co-workers and found two had silicosis. Both had been drillers.

The doctors assumed the problem was isolated and didn't pursue it. Then, in 1992, a 43-year-old former driller checked himself into the same hospital and changed everything.

The man, whom researchers wouldn't identify, had difficulty breathing and lost 72 pounds in four months. When he died, doctors found that his lungs were literally petrified with dust. Cocalis said he and other NIOSH researchers were stunned.

They started asking questions of mine-safety officials. Dissatisfied with the answers, the NIOSH researchers issued a warning to strip miners and operators nationwide about the danger of silica dust.

As part of its inquiry, the NIOSH team found that in the previous 10 years, only one of the dust samples taken at the mine where the 43-year-old had worked had contained more dust than allowed by federal law. Cocalis asked the dying man how this was possible.

"He said that he was told he'd be fired if he ever got another sample that was out of compliance," Cocalis said in an interview. "So he'd sit in the cab of a pickup truck and not run the drill while he was wearing the sampling pump. He just didn't do his job."

This was not an isolated occurrence, according to about 20 former strip miners interviewed by The Courier-Journal. They said federal inspectors, who are supposed to supervise dust tests, instead often drop off the sampling equipment and leave.

A LATE START

In 1994, the government began tougher enforcement

Armed with evidence of cheating, high dust levels and dying surface miners, the NIOSH researchers started pushing the Mine Safety and Health Administration to improve its oversight of strip mines.

Since even tiny amounts of silica dust can do harm, they persuaded MSHA to give its inspectors authority to cite mines with visibly dusty drills.

Since 1994, the agency has issued almost 300 citations a year for obviously dusty drills; the average fine has been about $250.

The average fine for failing a dust test, for years under $120, increased to $441 in 1994 but decreased to $197 by 1996. The agency also is inspecting strip mines more frequently, offering X-rays to miners in some states, holding seminars for mine operators and handing out brochures on black lung at strip mines.

Parker believes these actions are bringing results. Only 22 percent of the dust tests taken at strip mines by federal inspectors since 1994 have shown excessive dust levels. If the trend continues, silicosis rates among strip miners may start to fall.

The life of a strip-mine family: Pain, death — now anger

By GARDINER HARRIS
The Courier-Journal

BLACK SNAKE, Ky. — During the last year Charlene Howard's husband worked as a strip miner, she fought back tears every evening as she watched him crawl up the front steps of their Bell County home.

Terry Howard would sit on the second step, catch his breath, crawl two steps and sit again.

"He'd try and hurry so we wouldn't see him," Charlene Howard said. "It made me cry, and then I'd argue with him about him needing to quit."

Howard died in 1995 of silicosis, a virulent form of black lung disease. He was 45.

From 1980 to 1990, Howard worked the dusty life of a strip-mine driller. Now he's gone, and his wife is angry.

"I'm angry because I lost my best friend, I lost my husband, and my children lost their dad," she said.

It shouldn't have happened.

For 10 years her husband worked for Debra Lynn Coals on a drilling machine that she said had broken dust-suppressors. After work, he looked as if he had been dipped in gray flour.

Howard's grandfather and father-in-law had black lung, so he knew the risks. But they thought any disease was years away, and, when it did come, would be worth the pay of $8.80 an hour.

Tommy Evans, the owner of Debra Lynn Coals, said his drills always complied with the law. Federal records show that Evans was cited for excessively dusty drills in 1983, 1985 and 1988 and fined a total of $175.

After inspections became tougher in 1994, he was cited three times, with total fines of $228.

Asked if Terry Howard worked in dust, Evans said, "Well, there's dust everywhere.

"Terry Howard was one of the closest friends I ever had," Evans added. "We fished together all the time. We were neighbors."

One night in December 1988, Howard's chest hurt so badly he thought he was having a heart attack. The next day his doctor said his heart was fine, but an X-ray revealed that his lungs were all but destroyed. Howard was 40 years old.

Howard's doctor told him that he had to get off the drill. Howard told his boss, Charlene Howard said, and he was transferred to other, less-dusty equipment. But the change cut his hours from an average of 60 a week to about 40, and he feared he would be unable to pay his mortgage.

So a few months later, Howard went back to drilling. This time he wore a paper mask, but studies have shown they are ineffective. He could barely walk, but just had to sit to operate the drill.

"He came back (home) just as dusty," Charlene Howard said.

Terry Howard quit on Dec. 29, 1990. Three months later, his lungs collapsed for the first time. He was forced to breathe bottled oxygen 24 hours a day. During the next year, his lungs collapsed six or seven more times, and he didn't leave his house except to go to the hospital, Charlene Howard said. In September 1992, he had a double-lung transplant.

His new lungs worked surprisingly well for two years. Then he contracted pneumonia and his body began rejecting them. In June 1995, he called his three children together, told them that he loved them and left for the hospital one last time.

Charlene Howard said she never told her husband goodbye. "We'd been saying goodbye for the last three years," she said. "I knew I wasn't bringing him home again in anything but a box."

Charlene Howard watched as black lung killed her husband, a strip-miner. "I'd argue with him about needing to quit."

THE VOICES

FREDDIE BROCK, 47, of Whitesburg, Ky., underground miner for 12 years until 1991. He has black lung.

"Believe me, I've seen them turn the dust pump off or put sandwich bags over the sniffer, and I've seen the boss just make the men put them in their shirts so it wouldn't get the dust. . . .

"If the company operated by the rules, taking care of the men and hanging these curtains and ventilating dusty places, then a fellow wouldn't get near the dust that he did. . . . But the only time that got done is when the inspector is coming. And then that kind of slows production down, and before the inspector even got outside, the boss says get them (curtains) down, get them out of the way. . . .

"It would get so dusty our teeth would be black. We'd have to stop and rinse our mouths out with water to get the dust out. . . ."

MACK ARTHUR BAKER, 40, of Whitesburg, Ky., underground miner for 21 years.

"They run them (dust tests) for 30 minutes and it's supposed to be eight hours. . . . Either you run them like that or you don't work anymore. They tell ya' there's laws agin' that, but if I talk to anybody about it, there ain't a damn thing you can do about it."

ABOUT THE INTERVIEWS

Hundreds of miners — fearful of losing a good-paying job or of going to jail for cheating on dust tests — refused to talk to The Courier-Journal about dust-test fraud.

But 255 miners did talk. All are working now, or retired in the 1990s. Most are from Eastern Kentucky, and most are non-union. The newspaper also interviewed miners from Virginia, West Virginia, Pennsylvania, Tennessee and Alabama.

Most of the miners were identified through Kentucky black-lung and miner-certification computer records. They were not scientifically chosen.

The miners' reasons for talking varied. Some felt a moral obligation: "I'm a minister," said Charles Shepherd, 57, of Gordon, Ky., who left the mines last year. Shepherd said he and fellow miners falsified dust tests his entire 26-year career.

Others, despairing and disabled, feel they have little left to lose. "My lungs is gone, my legs is gone, I'm done for the rest of my life," said Jeff Johnson, 49, of Baxter, Ky. Johnson said he cheated on the tests for 20 years. "You can't get me in trouble. I'm already in trouble. People should stand up for the guys still working."

THE VOICES

RALEIGH ADAMS, 66, of Wooton, Ky., miner for 20 years until 1991. He has black lung.

"My experience is this: As long as I worked in the mines . . . different people were supposed to wear those dust machines, and they would never turn them on or never wear them, really. They would leave them laying on the power box or on the rib (wall), or something. If one happened to have one on, many times he would then turn it off if he got in a dusty area.

"The dust has not gone away. . . . I try to tell it like it is, and I'm telling you exactly the way it happened the 20 years that I was in the mines. I never saw one (dust sample) that was actually accurate."

KEN EVERSOLE, 56, of Perry County, Ky., a miner and foreman for 21 years until 1991.

"I'd say I took 50 to 100 samples in all my years underground. It's doubtful I ever did one of those right. I doubt any of the samples done where I worked was done right. . . .

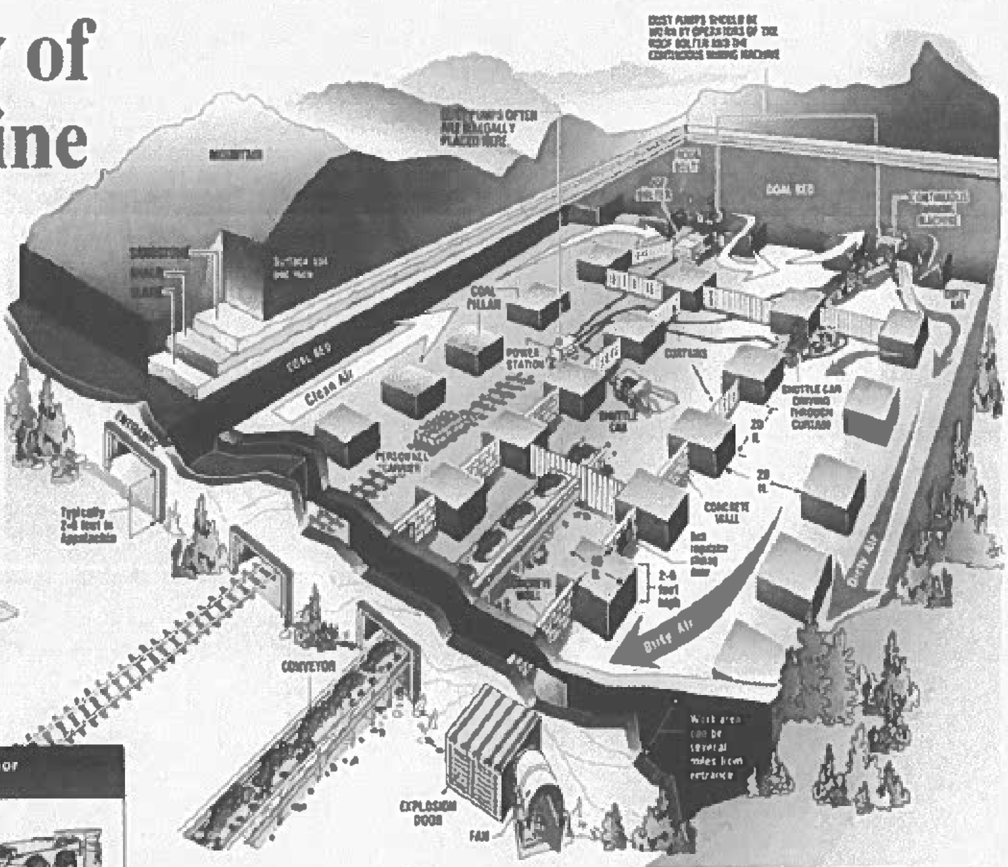
"You learn that if you're going to have to wear this extra equipment for a week, you'll do whatever you need to to get rid of it. And when you were done with them, you would take them back to the safety department. And if they were bad, they would say, 'It looks like it's a bad one,' and you'd have to do it again. . . .

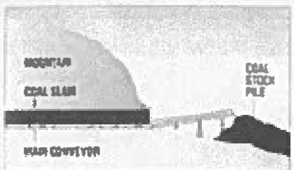
"So we put them back at the power center or in our dinner buckets. Or you'd just turn it off. If an inspector came by, you'd click it back on."

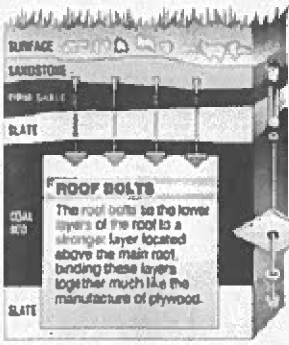
DUST, DECEPTION & DEATH

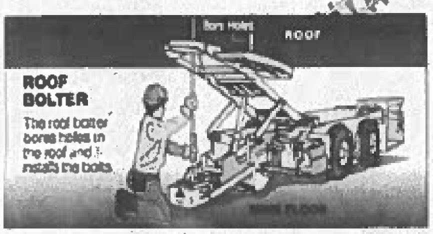
WHY BLACK LUNG HASN'T BEEN WIPED OUT

Anatomy of a coal mine









GRAPHICS BY WES KENDALL
THE COURIER-JOURNAL

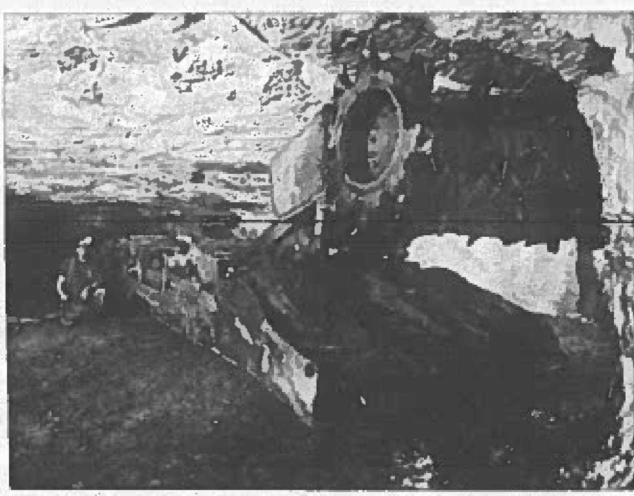
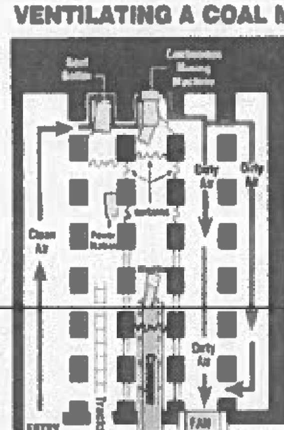


PHOTO COURTESY OF [illegible]

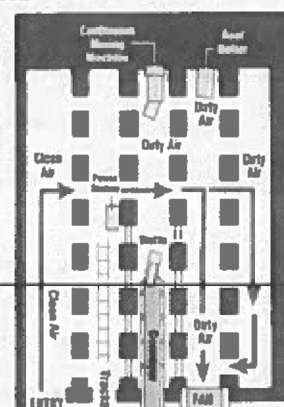
The spiked drum of the continuous mining machine extracts coal from a low-seam coal mine.

VENTILATING A COAL MINE



THE RIGHT WAY

This diagram shows the right way to keep airborne dust from accumulating in the working area of a coal mine. A powerful fan sucks air into the mine from the entries at the left. Concrete walls and temporary curtains direct the air past the working area, and the air carries away the dust. As the coal is cut and the mine advances, more walls are built and more curtains hung. And everyone works on the clean-air side of the mining machine.

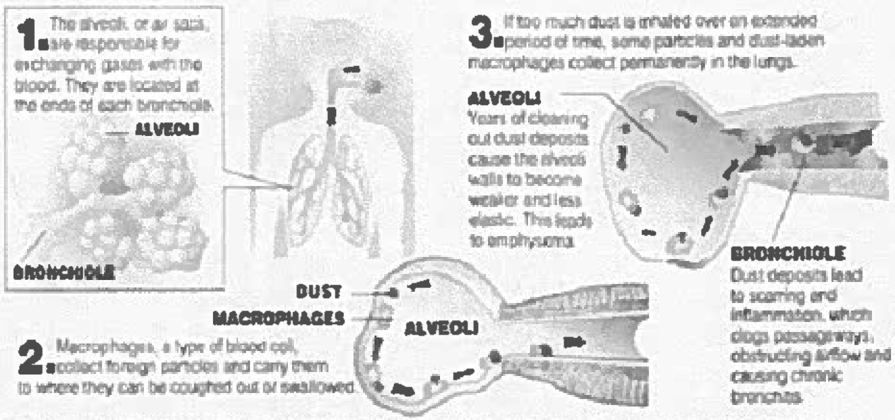


THE WRONG WAY

This diagram shows what happens when mine operators don't build concrete walls and hang curtains as the mine advances. The air is "short-circuited," and dust created at the working face stays there. Since curtains slow down mine vehicles and take time to put up, these conditions are common, many miners said in interviews. They also said that miners who operate the roof bolter often work in the exhaust air of the mining machine, as the diagram shows. This happens when mining machine operators — to save time — are told to mine back and forth instead of in only one direction.

What is black lung?

Black lung, or coal workers' pneumoconiosis, is the name given lung diseases caused by inhaling coal-mine dust. Only the smallest dust particles make it past the nose, mouth and throat to the alveoli deep in the lungs.

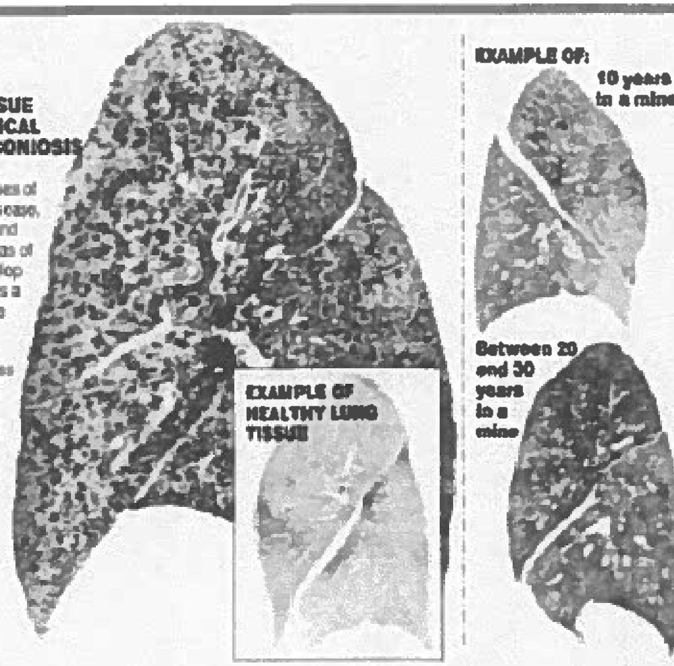


Sources: "Education [illegible] Lung," published by the National Jewish Center for Immunology and Respiratory Medicine in Denver; MSHA International Service
Graphic by Joanna Meshew, Gardner Hunts and R.G. Dunlop, The Courier-Journal

LUNG TISSUE WITH TYPICAL PNEUMOCONIOSIS

In most cases of black-lung disease, small stains and hardened areas of swelling develop in the lungs as a reaction to the dust.

Coal macules and nodules, small collections of dust and scarring, are distributed throughout the lung.



THE LANGUAGE OF THE MINES

Mantrip — Railroad vehicle that transports miners in and out of some mines.

Conventional mining — Mines where coal is blasted loose with explosives.

Continuous miner — Machine with a spiked, rotating drum that extracts coal by grinding it. It's the principal source of coal-mine dust in mines that don't use explosives to break up coal.

Roof bolter — Machine that stabilizes mine roofs by inserting bolts and glue. It's another source of dust.

Curtain — Temporary plastic partition used to direct air inside the mine.

Brattice — Permanent concrete-block wall built between columns of coal to direct air.

Dust pump — Machine, supposed to be worn on a miner's belt, that tests amount of airborne dust in mine.

Sniffer — Dust pump.

Buzz box — Dust pump.

Power center — Electrical transformer that steps power down from an outside feed to the mine's machinery. Miners often place dust pumps here instead of wearing them in the mine's working areas.

Dinner hole — The place miners eat lunch if their boss gives them a break. Usually near the power center.

Dinner bucket — Miner's once brought their lunch in buckets. Most now use coolers, but the name still sticks.

Intake air — Clean air sucked in from the surface, before it passes across the coal face where miners work.

Return air — Dusty air after it passes across the coal face where miners work.

MSHA — U.S. Mine Safety and Health Administration

Federals — MSHA inspectors.

Break — Hallway separating blocks of coal.

Section — Active, working part of a mine.

Coal face — Where coal is cut or blasted by miners.

Rib — Mine wall.

Scoop — Mine vehicle used for hauling miners and equipment.

Shuttle — Mine vehicle that hauls coal from the coal face to a conveyor belt that transports the coal out of the mine.

Dust box — A trap that captures dust on roof bolting machines. Also sometimes used to refer to a dust pump.

Rock dust — Crushed limestone spread around the walls and roof of a mine to prevent explosions fueled by coal dust.

DUST, DECEPTION & DEATH

WHY BLACK LUNG HASN'T BEEN WIPED OUT

U.S. mine agency ignored fraud

BY STEWART BOWMAN, THE COURIER-JOURNAL

This was once the entrance to Boogar Man Mining's No. 1 mine. On April 28, 1997, inspectors cited its operator for 66 violations, almost half life-threatening. After the inspection, the operator closed the mine. It was reopened by another operator who corrected the problems.

Cheating on tests now acknowledged, but response slow

Second of five parts

By GARDINER HARRIS
The Courier-Journal

DURING ITS first two decades, the federal agency responsible for protecting miners ignored overwhelming evidence that many coal-mine operators were exposing their workers to dangerous amounts of coal dust and covering it up.

Government auditors and independent experts warned the U.S. Mine Safety and Health Administration four times in the 1970s and 1980s that underground coal mines were sending it tests of airborne dust that were taken improperly. The agency's laboratory technicians recorded the results of those tests — which had so little dust that experts say they must be fraudulent — but nobody investigated why they were nearly free of dust.

"There was this whole charade of empty samples being sent to (the MSHA lab in) Pittsburgh, and they'd say they were fine," said Gerald Sharp, an epidemiologist who, as an anthropology graduate student at the University of Kentucky in 1978, researched the dust-sampling program.

"I was amazed that there were millions of dollars being spent for absolutely nothing."

Sharp's report and three others were read and discussed by top mine-safety officials. Some of the officials said in recent interviews that the agency's priority was preventing accidents, which got most of the attention from the public. They said they lacked resources to attack cheating and excessive dust, even though they had evidence that dust, which causes black lung, was killing far more miners than accidents.

In the early 1990s, the agency finally acted to stop cheating on dust tests, but it attacked only part of the problem.

The current agency head, J. Davitt McAteer, says that expecting operators to police themselves "defies human nature. ... The system is broken." McAteer wants to increase tests supervised by his inspectors and rely less on tests taken by operators.

But a year-long investigation by The Courier-Journal found that dust-test cheating remains widespread and efforts to stop it have been ineffective. In fact, 15 percent of air samples taken by operators in the 1997 fiscal year had so little dust that experts contend they can't be accurate. That's up from 10 percent four years earlier.

The mine-safety agency was first warned of the cheating six years after

See AGENCY
Page 4, col. 2, this section

Inspectors' ordeal exposed dangerous mine

By GARDINER HARRIS
The Courier-Journal

KITE, Ky. — In a coal mine no higher than a kitchen table, five government inspectors crawled more than a mile through mud that was sometimes a foot deep.

They wore gloves and kneepads, but blisters the size of silver dollars broke open on the knees of two inspectors. One injured his shoulder trying to keep his knees out of water.

The conditions in Boogar Man Mining's No. 1 mine were so dangerous that the inspectors would eventually list 68 violations of safety standards — almost half of them life-threatening. Since 1982, only 28 mines have gotten more citations in one day.

But first they had to get out of the mine. After more than three hours of crawling, the exhausted men decided to commandeer one of the mine's electric vehicles — something they knew they shouldn't do.

"We felt we had no choice," said Jim Langley, an inspector supervisor. "I don't know if two of those inspectors would have even made it out."

THE INSPECTORS

A closer look at government workers who try to regulate the mines

But taking the vehicle jeopardized the whole inspection because inspectors are not permitted to use private mine equipment.

The April 28, 1997, inspection of Boogar Man Mining demonstrates the misery of mining and the tough job inspectors often face, especially when operators don't help them.

The inspectors descended on Boogar Man Mining because of a formal complaint filed a few days earlier by Michael Brown, 22, of Floyd County, Ky., who had been fired by Freddy Hunter, the mine operator. Brown said he was fired for refusing to work in an area where the mine roof had not been supported by timbers or roof bolts, according to a Department of Labor complaint.

Brown said in an interview that his grandfather had died in a roof fall before Brown was born. He said he wanted to be sure he would get to know his infant daughter.

In a brief interview, Hunter said he never put his men in danger. "It all happened because we fired a man and he complained. ... We never got nobody hurt."

While telling a federal investigator of his dismissal, Brown described working conditions so unsafe that agency managers decided they should blitz the mine with multiple inspectors. To ensure surprise, the inspectors came from the agency's Barbourville office instead of the nearby Hindman office.

But when they showed up at the Knott County mine, an inspector from the Hindman office was already there. It was pure coincidence. He was there to do an unrelated safety inspection and had already written eight citations for problems outside

See DANGEROUS
Page 6, col. 1, this section

INSIDE

TESTS TOO CLEAN: The once-a-year air tests supervised by federal inspectors are done under ideal conditions because all equipment must first be working properly before the tests are conducted. **A5**

DUST — A TICKING BOMB: In the early hours of Dec. 7, 1992, an explosion killed eight of nine miners in Southmountain Coal Co.'s No. 3 mine in Norton, Va. It taught a deadly lesson: Dust can kill in other ways than disease. **A5**

ONLINE

This series can be found on The Courier-Journal's web site at: www.courier-journal.com

Agency ignored evidence of rampant dust-test fraud

Continued from Page One

Ed Kinder, a miner, wore a dust pump as he left Jericol Mining Inc.'s Darby No. 2 mine in Harlan County, Ky.

MINES CITED AND FINED FOR EXCESSIVE DUST

Chart shows percentage of underground mines that the federal government cited each fiscal year for excessive airborne dust, and the average fine for each violation.

Year	% cited	Average fine
1982	22	$100.71
[illegible]	23	$113.43
1984	22	$128.93
1985	22	$135.63
[illegible]	21	$151.82
[illegible]	23	$165.12
1988	22	$163.39
[illegible]	19	$176.93
[illegible]	20	$193.07
[illegible]	33	$195.80
[illegible]	21	$318.73
[illegible]	20	$350.14
[illegible]	31	$472.66
[illegible]	34	[illegible]
[illegible]	37	$560.63

Source: Courier-Journal computer analysis of U.S. Mine Safety and Health Administration records.

MORE WAS STILL LESS

Additional inspectors hired, but dust still low priority

'ADDICTION TO CHEAT'

Tampering with test strikes a wake-up call for agency

A QUIET ZEALOT

Once a critic of agency, new chief took muted steps

AGENCY'S 'BLIND SPOT'

Officials can't answer why agency was so slow to act

An inspector helped attach an air-intake tube to a dust pump. Air goes through the tube to a device that measures dust levels.

DUST, DECEPTION & DEATH

WHY BLACK LUNG HASN'T BEEN WIPED OUT

Dangerous mine challenged inspectors

Continued from Page One

the mine.

It was 11 a.m., but Hunter and the rest of the mining crew had left the mine after the Hindman inspector had called inside asking for a ride. The miners' departure prevented the inspector from seeing them at work — lessening the chance he would issue citations.

Complicating matters, the mining crew had driven out a mine vehicle with broken brakes, and no other vehicle was available. Langley called John Pyles, assistant district manager of the Mine Safety and Health Administration's Barbourville office, and asked what they should do.

"I guess by nature we're kind of suspicious anytime an operator pulls out like that on us," Pyles said. "That's why I told these guys to go ahead and crawl" into the mine.

HANDS, KNEES, GRIT

Exhausting inspection found major problems

The inspectors split up. Two crawled up the entry, or mine corridor, through which air is pulled into the mine; two went up the entry with the automated belt that carries the coal out of the mine; and one went up the entry where air returns to the outside — the place where miners go to the bathroom and dump trash.

The last was by far the worst assignment, but none had an easy time of it. The mine roof was no higher than 32 inches and sometimes dropped to 25 inches, not uncommon in mines. Twelve inches of that was often just mud.

The mine's electricity had been turned off by a worker, so a sixth inspector stayed outside to make sure the mine's ventilation fan remained on. As the mine branched out, the inspectors had to crawl back and forth through a dozen corridors to inspect the entire mine.

The electrical system was particularly bad, according to the inspection report. High-voltage cables, many badly spliced, were numerous. The mine's power center — a huge transformer that feeds the mine's electrical equipment — was so shorted out that it was still hot more than an hour after the power had been turned off.

"If the power had been on, we wouldn't have even gone by that ... because of the danger of fire," Langley recalled in an interview.

Michael Brown, the miner whose complaint led to the inspection, with his daughter, Morgan.

Brown said he often got painful electrical shocks while working. Sometimes the current would travel through the water on the mine's floor and shock his knees, or he would get a shock when he would brush up against a piece of equipment, he said.

"It never knocked you back, but it was strong enough that it would damn sure hurt you and would make you mad and make you cuss and make you get away from it," he said.

The inspectors found that a roof fall had closed off a main corridor. A layer of fine coal dust up to eight inches deep was found throughout the mine — enough to cause a catastrophic explosion, the inspection report noted.

The inspectors said no ventilation curtains had been put up. Curtains direct clean air to the working areas of the mine, carry dust away from miners and also reduce the chance of an explosion.

The inspectors measured the mine's carbon monoxide — a byproduct of the explosives used to dislodge coal in Boogar Man and some other mines. With proper ventilation, carbon monoxide is quickly swept away from working areas, but high levels of the gas were detected in some areas hours after the last explosion.

"This was about equal to the worst (working conditions) I've ever seen," said Roger Dingess, who has been a mine-safety inspector for 20 years. "I've seen mines just as bad but probably not any worse."

Brown said in an interview that he often worked in blinding clouds of dust. Pyles said it's unlikely that the Boogar Man mine, with no curtains hung and dust piled high in places, could have met the federal limit of 2.0 mg. of dust per cubic meter of air.

But seven of 12 air tests taken in the mine's working areas in fiscal year 1997 had just 0.1 mg. of dust per cubic meter of air — an impossibly small amount, experts say. An air test overseen by a mine-safety inspector two months before the blitz had almost as little dust — 0.2 mg.

Pyles defended the inspector, saying the mine operator had time to fix ventilation and other dust-control equipment before the test. Whenever inspectors supervise tests, they will order any safety problems fixed before running the tests. That helps explain why dust levels measured by inspectors rarely reflect the amount of dust miners breathe on most days.

'WE TOOK THAT SCOOP'

Reduction in fines follows apology to mine's operator

Exhausted and hurting, the five inspectors huddled at the deepest part of the mine and decided that they had seen enough. But they weren't sure they could handle the crawl out. Somebody mentioned that a scoop, an electric mine vehicle, was nearby.

"We talked about it, and we knew what would happen if we took that scoop," said Langley.

Federal law gives MSHA inspectors the right to enter any working mine at any time. But it does not give them the right to operate private mining equipment. They piled into the scoop anyway. To make matters worse, they got it stuck in a hole just short of the mine's entrance. They crawled the rest of the way, emerging more than four hours after they had crawled in.

The next day, the inspectors met with Pyles, who ordered the mine closed until the 30 life-threatening violations were fixed, Pyles said.

But Hunter complained to the Mine Safety and Health Administration's headquarters about the scoop being commandeered.

Pyles met with Hunter and apologized for the scoop incident. He rescinded his orders closing the mine, threw out six of the citations, agreed to amend five others to less serious charges and gave Hunter more than a month to fix most of the problems.

"Based on the fact that we may not have given you enough time to begin with and that we got your scoop stuck, we are going to drop back and give you the chance to get these corrected in a reasonable time," Pyles said he told Hunter.

But rather than fix the problems, Hunter abandoned the mine.

"I had to give it up," Hunter said. "They wouldn't leave me alone no ways. I didn't have a chance there."

Now working as a foreman at another mine, Hunter has vowed never to pay the fines that resulted from the citations he got at Boogar Man. Once an owner abandons a mine, MSHA's citations often go unpaid. Hunter said he normally had very good relations with MSHA inspectors, but he is convinced the MSHA blitz was unfair.

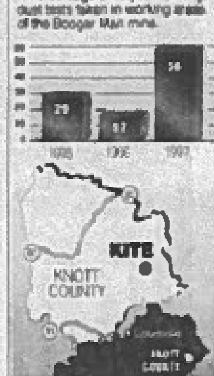
"I think they are dirty sons of bitches myself," Hunter said. "I know they targeted me. It don't take a genius to figure that out.

"Why? I got no idea. I don't know why they can think they can do tricks like that and write me up."

A new operator has taken over Boogar Man. The problems have been fixed, and a judge ordered the new operator to temporarily reinstate Brown pending a final ruling on whether he was improperly fired.

BOOGAR MAN MINING

Percentage of very low 0.1 mg dust tests taken in working areas of the Boogar Man mine.



PHOTOS BY STEWART BOWMAN, THE COURIER-JOURNAL

Michael Cline of Wayland, Ky., removed rock from the coal as it moved along a conveyor belt. The mine had been run by Boogar Man Mining, which was cited for numerous violations. But a new operator corrected the mine's problems and re-opened it.

Inspector Roger Dingess, right, said the mine's condition was "equal to the worst I've ever seen." With him are two other members of the inspection team that day: Cecil Partin, left, and John Arrington.

Ideal conditions for tests taint results

By GARDINER HARRIS
The Courier-Journal

Once-a-year air tests supervised by federal inspectors in underground coal mines rarely measure the dangerous amounts of dust that many miners breathe daily because testing is done under ideal conditions.

By law, inspectors can't allow a mine to operate unsafely, so when they arrive, they order mine operators to fix any safety problems, including dust-control equipment, and fine them for any violations. Only then can production of coal — and thus dust — and testing truly begin.

The point of the inspector tests is to make sure a mine's dust controls, when working, are effective — not to measure the amount of dust miners normally breathe.

"We don't just show up and put (dust) pumps on them (miners) and then sit down and say, 'Do whatever,'" said Joe Pavlovich, district manager of the U.S. Mine Safety and Health Administration's Barbourville, Ky., office. "What they (operators) do when we're not there is the concern."

In fact, many of the 255 miners interviewed by The Courier-Journal said the air is clear only on the day when inspectors supervise tests because only then are dust controls in place.

"That was a glorious day," said Herbert H. Metcalfe, Jr., 40, of Centertown, Ky., a miner for 13 years in Harlan County until 1995. "You could breathe and chew gum that wasn't crunchy."

The tests also are unrepresentative of normal conditions because of legal loopholes and fraud:

■ Federal law allows mine operators to cut production by 40 percent during the tests.

■ Many miners say they cheat the tests the minute inspectors turn their backs.

■ Miners also say some inspectors fail to watch closely for the eight hours dust pumps are strapped to the miners, and some inspectors have been convicted of taking payoffs.

Despite the ideal conditions under which inspector tests are taken, some mines fail to meet federal standards. Inspectors supervised 1,736 tests in mines' dustiest areas in the 1997 fiscal year, and 259, or 15 percent, exceeded 2.0 mg. of dust per cubic meter of air — the legal maximum.

In its investigation, The Courier-Journal found that air tests taken every two months by many operators are routinely cheated and that many miners work in illegal levels of dust. The industry denies this and cites the results of inspector tests as proof.

"Set aside for a minute the operators' samples," said Bruce Watzman, vice president of safety and health for the National Mining Association. "If you look at just the MSHA samples, the fact of the matter is that across the industry, we are well below 2.0 mg."

Indeed, the averages of the dust tests taken by operators and those supervised by inspectors aren't that different. Of the tests taken last year in mines' working areas, the operators' average was 1.0 mg. while the inspectors' average was 1.3 mg.

Miners said, however, that the inspector tests mean little. Before the tests, miners hang ventilation curtains that direct fresh air to working areas; unclog water sprays that hold down dust; and clean mesh screens that filter the air — all rare measures on most other days, they said.

In each of the last five years, inspectors cited about two-thirds of mines for ventilation violations — but these problems were corrected before the inspector tests.

'WE GOT COMPANY'

Early warning system puts mines on alert

Inspectors' visits are supposed to be unannounced, but mine operators often are warned that inspectors are coming, giving them time to get dust controls working and avoid fines.

Coal-truck drivers radio a mine when they see inspectors' distinctive sport-utility vehicles with government plates heading toward a mine.

If that fails, a man at the mine's mouth phones inside when an inspector drives up, scores of miners told The Courier-Journal. Since it can take as much as an hour to reach a mine's working area, the warning provides time to hang curtains and do other cleaning.

"A lot of times, they try to keep you outside and keep you from going underground," said Jim Langley, an MSHA inspection supervisor. "They'll say the mantrip (a transport vehicle) is broke down."

Other mine operators simply shut down production for the day. When the inspector returns the next day, the mine has been cleaned.

Miners also said coal production is cut during an inspection, which reduces dust. Federal law allows operators to reduce production by 40 percent during dust tests supervised by inspectors. (Operators are allowed to slow production by 50 percent during their own dust sampling.) A federal task force recommended in 1996 that the production decline be limited to 10 percent, but MSHA has not yet proposed that change.

The agency has proposed increasing the number of inspector tests to four per year in all mines, and has already done so in some areas. Inspectors currently conduct safety inspections four times a year.

HOW MINERS CHEAT

Miners use many tricks to thwart inspectors

Even though dust levels are tested when mines are at their cleanest, many operators still cheat the inspector tests, miners said.

To make sure miners are sampling correctly, inspectors have to crawl among miners who are often hundreds of feet apart. The miners said they used to simply turn the dust pumps off when an inspector turned his back; but in 1993 MSHA changed to pumps that couldn't be turned off. To thwart the new pumps, the miners said they stick cotton or cigarette filters over the intake hole or put the hole under their clothing.

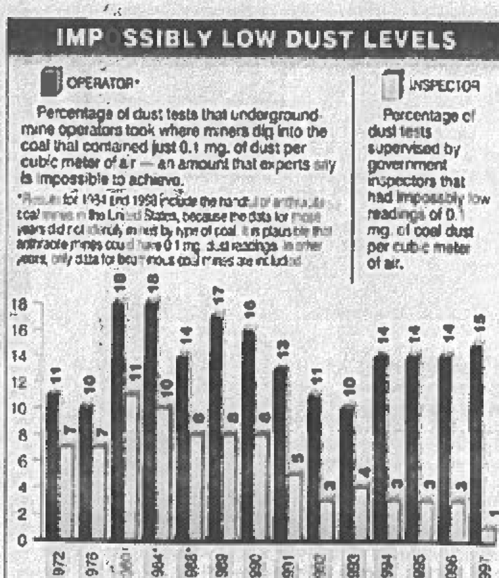
"You put your coveralls over it ... or cut a piece of rag and cover over it where the dust won't get in," said Hershel Asher, 58, of Hyden, Ky., who retired in 1995.

Many miners said such ruses aren't needed for long because many inspectors leave the mine early.

"They'd stay 'til everything got going real good and then catch the first mantrip out of there," said Merle Hacker, 53, of Hyden, who worked underground for 18 years until 1998.

Miners said they then hang the pumps in clean air, away from the work area.

"You know, we was going to bomb Saddam Hussein because he wouldn't let inspectors do their job," said Ronald Cole, 52, of Virgie, Ky., who mined for 23 years until 1994. "And I thought, 'Man, you got ... inspectors right here in Pike County not doing their job, and there ain't nobody doing nothing about it.'"



Source: Courier-Journal computer analysis of U.S. Mine Safety and Health Administration records.

BY JOANNE VEENEW, THE COURIER-JOURNAL

TAINTED TESTS

Impossibly low results mask true level of dust

Because of cheating and lax supervision, many dust tests overseen by inspectors, especially in the 1970s and 1980s, had so little dust that they were obviously fraudulent.

According to The Courier-Journal's computer analysis of 2 million dust-test records, more than 8 percent of the inspector samples supposedly taken in working areas of bituminous, or soft-coal, mines during the 1980s had just 0.1 mg. of dust, an impossibly small amount, experts say.

The percentage of such 0.1 mg. tests overseen by inspectors has steadily declined in the 1990s — to 1 percent in fiscal year 1997.

The decline is probably the result of the new dust pumps that can't be turned off, said Kathy Snyder, an MSHA spokeswoman — though miners say they have found ways to cheat these, too. She also said inspectors, whose annual base pay ranges from $30,257 to $47,589, were encouraged in the past to perform safety inspections while the dust tests were done, but now they are told to watch the tests closely.

J. Davitt McAteer, the assistant secretary of labor over MSHA, said when the agency learns of inspectors doing poor work, it offers additional training and supervision.

The decrease in very-low dust readings also may reflect less corruption among inspectors.

"It certainly appeared that (corruption) was extremely widespread" in the 1970s and 1980s, especially in Eastern Kentucky, said Ray Carroll, director of fraud investigations for the Labor Department's inspector general's office. "I don't think that's true anymore," although "I'm sure it still goes on to some degree."

CORRUPTION HOTLINE

To report suspected problems with a federal mine inspector, call the Labor Department's Inspector General's office at 1-800-347-3756.

Thurman Johnson, former safety director of Kenny Branch Coal Co., said he used to pay off inspectors in MSHA's Pikeville, Ky., office, according to the transcript of a hearing last December in U.S. District Court in Frankfort, Ky. He admitted he used to keep part of the company's cash.

"I did keep a third of it, and I left the rest of it laying on the desk — what they called the coffee desk — in the Mine Safety and Health office," Johnson testified. An MSHA inspector himself from 1975 to 1985, he failed to report this illicit income and was convicted of falsifying a workers' compensation form.

Carroll said corruption waned after his agents descended on Eastern Kentucky in 1994. Their investigations led to the convictions of six Pikeville inspectors for accepting bribes to overlook safety violations. Six other MSHA employees, all but one an inspector, have been convicted of fraud since 1992, according to the agency. While Carroll said fraud had declined, his agents are currently investigating more than a dozen of MSHA's 1,000 inspectors nationwide for alleged misconduct. He wouldn't say whether any are from Kentucky.

Two of the convicted Pikeville inspectors, Clifford Crum and John W. Banks, oversaw air tests with 0.1 mg. of dust. In 1983, 15 of the 29 supervised by Crum and 16 of the 31 overseen by Banks had that little dust.

But in that year, 11 other Pikeville inspectors and 18 others nationwide oversaw a higher percentage of nearly dust-free tests than either Crum or Banks. For 17 of them, every test they supervised had 0.1 mg. of dust. The newspaper found that at least four still oversee dust tests for the agency. MSHA refused to allow them to be interviewed.

Asked why MSHA continues to employ those inspectors who have overseen many cheated dust tests, McAteer, the agency head, said his ability to fire people is limited. "You don't have the slash-and-burn approach that you might have in private industry," he said. "We have 1,000 inspectors, and of that number, some won't be as quality as we'd like." But he said most are honest, and "when we find corruption, we will investigate it vigorously."

THE SOCIAL WEB

Mining community ties can influence inspectors

The corruption of mine-safety inspectors is often more subtle than payoffs and kickbacks. Bradley Whitaker, a mine foreman from Letcher County, said inspectors would often tell him when they were coming, which is illegal. "They was just being nice," said Whitaker, 34, who left the mines last year. Such advance notice is common, many miners said.

A web of social connections binds inspectors and coal operators in small towns. Foremen and inspectors see each other at church and at high school sporting events. Many inspectors and foremen once worked together as miners. Some are related.

There also is a shared understanding among some operators and inspectors that dust tests are made to be cheated.

Michael Hoskins, for instance, said a supervisor told him last spring to leave his mine's working area and sit in clean air while he wore a dust pump during an inspector-supervised air test. Hoskins, 37, of Stinnett, Ky., said the inspector knew what was being done but did nothing. Hoskins — who was later fired for refusing to work in excessive dust but then reinstated — said he looked at the inspector with disapproval.

Near the end of the shift, the inspector called Hoskins and a few other miners together, and he "told us that, basically, the mine couldn't run legal. That they had to do what they did, and if they didn't, they could shut the mines down. And if they shut the mines down, we wouldn't have a job. And if we didn't have a job, he wouldn't have a job."

THE VOICES

EARL SHACKLEFORD, 37, of Wallins Creek, Ky., foreman and miner for 17 years until 1993.

"When I was foreman, none of the sampling machines spent any time at the face. . . ." He said he took the dust pumps from his men and put them in clean air away from the mine's working area.

"I'm ashamed of it because I turned my head on it. As a mine foreman I took an oath, and I broke it when the operator made us sit in that dust. The very first time I should have quit. . . .

"They (inspectors) wouldn't spend more than 30 minutes with them (dust pumps). I've never seen an inspector stay with the pumps, not in all my mining days. Why? Because if you had a choice between wallowing around in 30 inches in mud and 50-degree water like a pig, or being outside in the sun, which would you do?"

LENVILLE BATES JR., 24, of Thornton, Ky., miner for four years.

"When the inspector comes, they'll call inside and put air to the face. Otherwise there is no air to the face. Sometimes you can't see five foot in front of you. . . .

"When the inspector gives you a dust box (air sampling machine), if he don't come in the mine with us, it gets left at the power center (in clean air). Or I've seen a plastic bag put over the suction part. The inspector will say that he will be back in a few hours, and instead of the men wearing them, they'll just stay by the power center. Sometimes the inspector comes in with us for 30 minutes. When he leaves, the boss will call in and tell them to bring all the pumps back out."

THE VOICES

JAMES DAVID CODY, 41, of Amburgey, Ky., miner for 10 years until 1993.

Cody told of working in a mine with a broken ventilation fan: "The fan was completely off, and we couldn't tell the difference because we never got any air anyway. . . . I couldn't even see (for the dust), and I was talking to a federal mine inspector. . . . He says, 'Cody, don't you like this air?' And I said, 'No, I think it sucks.' . . . He didn't do nothing. . . .

"They (the bosses) would tell you, 'The inspector'll be here tomorrow or next day, or whatever.' . . . Most of the time, the inspectors would tell you to clip this (dust sampler) on you and you'd take it in there with you, and they'd stay outside. So we'd hang them in the intake air, the fresh air course, and hang them up and take them out at the end of the day. And he (the inspector) would sit there and drink coffee. Now don't get me wrong. There are some good inspectors, but they're few and far between."

HERBERT H. METCALFE, Jr., 40, of Centertown, Ky., miner for 13 years until 1995.

"The only time ventilation curtains were ever hung was when the mine inspectors were there. That was a glorious day. You could breathe and chew gum that wasn't crunchy. . . .

"I've never seen dust pumps being used correctly for an entire eight-hour shift. I have seen them in the intake (clean) air, sitting in dinner buckets at the dinner hole, covered up with rags, under coal miners' shirts, hung outside the mine in fresh air, and just about every place other than on the coal miner during actual working conditions underground."

WHAT THE EXPERTS SAID ABOUT CHEATING

"... In May 1974, (government) inspectors found that in two mines in the Mount Hope (W.Va.) District, the dust levels exceeded the 2.0-milligram standard and cited the operators for violations. Samples taken during the same month and the following month submitted by the mine operators showed 20 of the 50 samples had dust level concentrations of only 0.1 milligram."

— "Improvements Still Needed in Coal Mine Dust Sampling Program And Penalty Assessments and Collections," General Accounting Office, 1975.

"One dust sampler ... said this company is paid $100 per mine per section per month no matter how many dust samples it actually collects and that therefore it is to the sampling company's advantage to never have a sample exceed 2.0 mg., which would require the resampling of miners.

"The sampler said that as an employee of this company, he dropped sampling pumps off at mines in the morning, allowed the companies to sample as they saw fit, and then retrieved the pumps at the end of the day. He said he sometimes observed samples being collected in cardboard boxes and in other inaccurate ways and ... he would generally find conditions dusty with few measures taken to reduce dust levels. The sampler said that in his three years with this company, not one sample collected at .. client mine exceeded 2.0 mg (the government limit)."

— "Dust Monitoring and Control in the Underground Coal Mines of Eastern Kentucky," by Gerald Sharp, 1978

The results of these analyses show that ... there is a larger proportion of very low samples obtained by operators than inspectors. Taken along with the previous analyses and expert judgment on low samples in operator data, there is strong evidence that these low samples do not well represent actual exposure conditions.

— "Assessment of Potential Biases in the Application of MSHA Respirable Coal Mine Dust Data to an Epidemiologic Study," by Noah G. Seixas, et al., 1990

EDITORIAL

Changing the culture of coal mining won't be easy

LABOR organizer Mother Jones used to tell this story:

I was talking with a miner's wife one day when we heard a distant thud. She ran to the door of the shack. Men were running and screaming. Other doors flung open. Women rushed out, drying their hands on their aprons.

An explosion!

Whose husband was killed? Whose children were fatherless?

"My God, how many mules have been killed!" was the first exclamation of the superintendent.

Dead men were brought to the surface and laid on the ground. But more men came to take their places. But mules — new mules — had to be bought. They cost the company money. But human life is cheap, far cheaper than are mules.

The temptation is to regard Mother Jones as an anachronism. As a firebrand whose parables and condemnations belong to another era, before worker protests, union pressure and government regulation began to have an impact on the horrific safety practices in American coal mines.

But the recent history of dust sampling, and government monitoring of dust control, suggests that Mother Jones would recognize the coal industry, if she were around today. Its central dilemma remains.

In much of this industry, workers are still treated with contempt, while economic concerns are viewed as paramount.

It's not as if the U. S. Mine Safety and Health Administration hasn't been warned that its regulatory efforts have been inadequate. It's not as if the agency hasn't, from time to time, tried to do better. It's that the industry's inclination to minimize worker health and safety concerns, when the demands of production are at issue, is always there. It never goes away.

In the early 1990s, the agency finally recognized that mine operators were cheating on dust tests, but it addressed only part of the dilemma. Top federal administrator J. Davitt McAteer says it's absurd to expect that operators will police their own dust problems. He laments that the "system is broken." And he wants to expand the testing that is supervised by federal inspectors, relying less on tests that are taken by operators. He wants more money for more inspection.

Mr. McAteer is right. More oversight would help.

But it's the very culture of this industry that must change, which will require an unambiguous, long-term commitment to something better.